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U. S. COAST AND GEODETIC SURVEY STEAMER "FATHOMER" FOR PHILIPPINE SERVICE.

By G. R. Putnam,* M. Am. Soc. C. E.

The Coast Survey steamer "Fathomer" was recently placed in commission at Manila, and will be employed in the extensive surveying operations that are necessary to provide proper charts of the Philippine Islands. The vessel, which is shown in Figs. 1 and 2, differs in important respects from what has been customary in government vessels for similar duty, and a brief outline of the principal features will be of interest from an engineering point of view.

The general plans and specifications for this vessel were prepared in the office of the Coast and Geodetic Survey at Manila, mainly by Dr. C. C. Yates, Assistant Coast and Geodetic Survey, who also acted as inspecting officer for the government during the construction. Mr. J. C. Dow, Nautical Expert, Coast and Geodetic Survey, added valuable suggestions in the planning of the vessel. The detailed working plans were prepared by the contractor.

In the general design of the vessel there was no hesitation in departing from traditional customs that have generally determined the arrangements of government vessels. The sole object in view was to provide a vessel that would be conveniently adapted for survey work in a tropical country, and that would have quarters for officers and crew suitable for a warm climate.

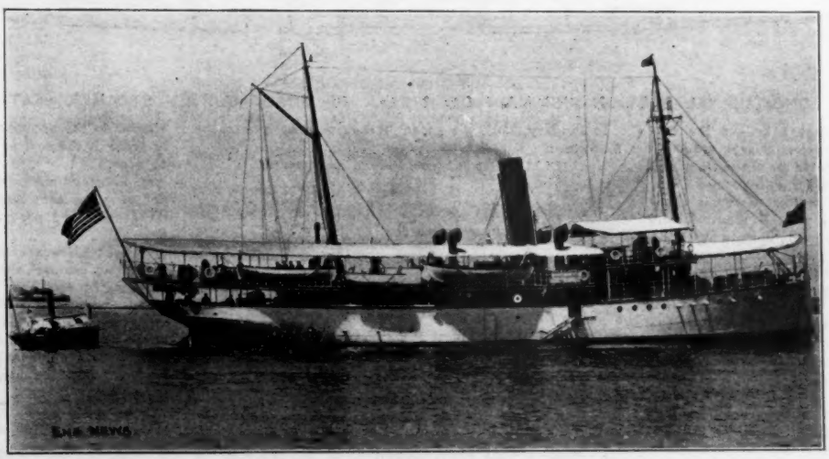
The main requirements to be met were moderate size for economical operation and yet sufficient size to insure seaworthiness in tropical storms and permit the vessel to work on any coast of the Philippine Islands; economical speed; moderate draft to permit of entering small harbors, convenient bridge, drafting room and other accessories for surveying operations, capacity for coal, water and stores to permit of vessel remaining away from base of supplies for at least a month, officers' quarters convenient to their work and comfortable in the tropics, crews quarters suitable for a native crew.

The "Fathomer" was built by the Hongkong & Whampao Dock Co., at Hongkong, under a contract with the Philippine government. The vessel was constructed under Lloyd's inspection as well as the inspection of the representative of the survey. Because of Lloyd's requirements nearly all the material had to be brought out from England. The contract was signed Jan. 27, 1904; the trial trip was had on Dec. 12, 1904, and the vessel was delivered in Manila Bay on Jan. 19, 1905. The contract price of the vessel at Hongkong was $66,550, and including delivery in Manila Bay and extras, but not equipment supplies, the total cost was about $70,000.

*Director of Coast Surveys in the Philippine Islands, Manila, P. I.

The "Fathomer" is a steel vessel of 368 gross tons; length over all, 160 ft.; breadth, 25 ft.; mean draft, 10 ft. The hull is divided into seven water-tight compartments. In place of a double bottom, the lower decks both forward and aft of the machinery space are of steel and water tight, and there is special strengthening above Lloyd's requirements under the boiler and engine-room space. The mechanical equipment was made simple, because of the intention to employ mainly a native crew. A Scotch boiler and compound engine furnish the required speed of ten knots. There is provided a dynamo, evaporator, small refrigerating machine, and steam windlass.

Special attention was given to the boat equipment, an important feature in the success of surveying work. The "Fathomer" carries a 28-ft. steam launch, a 24-ft. whaleboat, a 20-ft. cutter, a 16-ft. dinghy, and a 12-ft. punt or flatboat. Wellin davits are provided for the launch, and the falls lead to the steam windlass.



FRONT VIEW. U. S. COAST SURVEY STEAMER "FATHOMER" FOR PHILIPPINE SERVICE.

A deck house aft furnishes space for galley, pantries, cold storage room, quarters for native draftsmen, bathroom and toilet rooms; the after hold is used for crew's quarters, with rooms for native petty officers and for messmen.

Under a raised deck forward are the officers' quarters and wardroom. The captain's cabin is immediately abaft the collision bulkhead. Next to the cabin is a small companionway to the deck, and then follow a wardroom running athwartships, and abaft this on each side of passageway leading to the main deck are six good-sized rooms for the officers. Each of these rooms is 7 × 9 ft., and contains bed, drawers, desk and wash bowl. Special attention has been paid to ventilation, each room having two ports and overhead ventilation. Sliding doors between the rooms permit of throwing in one the whole space occupied by wardroom and officers' quarters.

On the deck above the officers' quarters in a separate deck house is a drafting room of unusual dimensions, 21x10 ft., containing two large drafting tables and two decks, as well as book cases, chart drawers, etc. This drafting room has windows on every side and makes a commodious and attractive workshop.

Above the drafting room is the bridge deck, covered by an awning. This bridge is 21x24 ft. and forms a most convenient place for survey work as well as navigation. There are brought together on this bridge all requisites for navigating the vessel as well as for surveying operations. Here are the steering wheel, standard and navigating compasses, searchlight, telegraphs and speaking tubes, drafting table, sounding gratings, storage space for nautical instruments and charts, and a skylight communicating directly with the drafting room below. The arrangement of officers' quarters forward has the great advantage of having them in close proximity to their work either navigational or surveying, and incidentally this is much the coolest part of the vessel in the tropics. The advantage and comfort of these arrangements has been well proven by the short experience already had with the vessel.

Abaft the bridge, a shade deck, at a lower level, extends to the stern of the vessel. The launch is carried on the rail of this deck, and there is space for perishable stores, and on the after part of it is mounted the equipment of sounding machines, consisting of one deep sea machine, one Kelvin machine and one submarine sentry. The deep sea machine has a steam engine for reeling in and an extra light reel for use in ordinary sounding.

Under the wardroom forward are convenient store rooms with separate spaces for each class of stores. Abaft of these are water tanks and a large transverse coal bunker. The bunker capacity is 95 tons of coal, and the tanks hold 6,000 gallons of fresh water. The foremost carries a crows-nest, very useful in looking for coral reefs and shoals.

The vessel has a full equipment of modern surveying instruments, including theodolites, plane tables, tide gage, sextants, chronometers, protractors, base tapes and level. As not ordinarily supplied to American vessels, may be mentioned the Kelvin navigating compass with electric illumination from below, a self registering barometer, very useful in keeping a lookout for typhoons; an English sextant with the improvements adopted in the British surveying service; Field's parallel rulers, very useful in quick chart work; Cust's protractors, a simple device for laying off angles where the three arm protractor cannot be used, and standard spacing dividers.

THE ORGANIZATION AND CONDUCT OF THE BROOKLYN BUREAU OF STREET REPAIRS.*

By Edwin J. Fort,† M. Am. Soc. C. E.

Until very recently it has rarely been conceded by those in authority in American cities that street repairs is a proper field for the activities of an engineer. Notwithstanding the fact that his profession deals primarily with the economic side of matters, and that modern education provides thorough instruction in economics, and notwithstanding, also, that his experience makes him capable of handling men, a butcher or a grocer or a tradesman of almost any kind is usually preferred when a head of the bureau of street repairs is required. So nearly universally is this true that I believe the discussion of the subject of street repairs by such a society as this is unusual and may prove to be interesting and instructive for that reason, if not for others.

It is considered such a simple matter to repair roads and pavements that no particular skill is required, and the position of superintendent of this bureau with an appropriate salary attached to it is usually considered a perquisite of the victorious political party. This was more generally true before the days of improved pavements. It must be conceded that little skill was required and less was shown in laying the old time cobblestone pavement. It is not extravagant to say that if all the money set aside for this purpose had been wisely spent under expert supervision our cities to-day might be not only well paved but well served with other public utilities which make the crowded life of great metropolitan districts possible and even pleasant.

The Borough of Brooklyn, of the City of New York, to whose street repair organization this paper refers, is somewhat of an exception to the rule in the manner in which this department of the public service is managed.

In January, 1902, the present Bureau of Highways, which previously, under the Greater New York Charter, had been a branch of the Department of Highways controlled by a Deputy Commissioner of Highways, was organized as one of several separate bureaus under the jurisdiction of the Borough President, whose heads reported to the Commissioner of Public Works. The Bureau of Highways was placed entirely under the control of civil engineers. The chief engineer was given control of all matters relating to the construction and repair of pavements and all matters relating to laying out, opening, closing and improving streets and roads, etc.

An assistant engineer was placed in charge of the division of repairs of this bureau and the whole service was entirely reorganized.

The Borough of Brooklyn covers an area of 77½ square miles. Somewhat more than one-third of this territory is closely built up and contains fully four-fifths of the total population. A large suburban area is quite fully improved but does not contain a dense population, while nearly two-fifths of the whole borough is almost totally unimproved, and contains a rather sparse population. Street systems are not yet indicated on the ground, much of which is still used for truck farming. Nearly all of this has now been acquired by improvement companies that are rapidly making the improvements necessary to convert it into suburban home sites.

In January, 1902, there were:

216.8	miles	of	cobblestone pavements,
119.87	"	"	granite "
95.14	"	"	asphalt "
5.31	"	"	wooden block "
82.15	"	"	macadam "
47.39	"	"	Belgian block "

making a total of 566.66 miles of paved streets and roads. In the suburbs there were several hundred miles of unpaved roadways.

In January, 1905, the above mileage had changed to the following:

113.73	miles	of	cobblestone pavements,
142.34	"	"	granite "
211.59	"	"	asphalt "
4.40	"	"	brick "
43.13	"	"	Belgian block "
2.00	"	"	wooden block "
96.16	"	"	macadam "

Total..614.38 miles.

Until 1901 the asphalt pavements were kept in repair by contract, as follows: The various streets out of guarantee were grouped according to age and bids were submitted naming a price per square yard for the whole area in each group, for repairing and maintaining for one year. In 1900, the last year this method of keeping this pavement in repair was followed, the average cost to the city per square yard for repairs was 15.9 cts.

This method of calling for bids was thought to result in too great expense and in July, 1901, bids were called for naming a price per cubic foot for binder and wearing surface actually used in making repairs, and the reduction in cost to the city was so great that this method has since been followed.

In 1904 the prices bid for this material were: Top, 85 cts. per cu. ft.; binder, 30 cts. per cu. ft. The average cost per square yard was 4.2 cts., a notable reduction from the former method. It is probable that in 1905 there will be another reduction in the cost of asphalt repairs.

This contract is let in the winter and as soon as weather conditions are suitable in the spring the company which secures the contract commences work with a number of gangs of men (usually about six) and usually within six weeks puts all asphalt pavements in repair. From that time throughout the season a few repair gangs are kept constantly at work going over the older pavements and repairing holes as they appear. The oldest pavements are sometimes repaired four times in a season.

Each repair gang usually consists of 10 or 12 men, a foreman and a steam roller man. The number of teams employed in hauling material to the street varies with the length of haul, but a gang of this size can usually lay 350 cu. ft. of material per day, if the pavement is in ordinarily bad condition, and the distance over which the work is distributed is not too great.

An inspector for the city is present with each gang and marks with crayon the area of each patch to be cut out and measures the contents of each truck as it arrives on the work, takes its temperature, takes samples for analysis and otherwise supervises the laying of the material.

He makes a daily report to the office on a blank similar to the accompanying one and a permanent record is made of the cost of repairs of each contract from year to year.

All openings made by plumbers and others are repaired by the same contractor at a price per square yard for the asphalt and per cubic yard for the concrete foundation.

These repairs are paid for from a fund accumulated from the regular charges for such openings: $13 for openings of less than 5 sq. yds. and $1.25 per sq. yd. for all in excess of this. An inspector carefully measures all of these openings and makes the proper reports to the officer, from which the contractor is paid.

All openings made in pavements under guarantee are repaired by the contractor who laid the original pavement at the price bid for this pavement.

It should be said that the money spent for asphalt repairs represents the amount necessary to keep the asphalt pavements in good repair and not as is so often the case the amount the city can afford to spend or the officials are willing to appropriate for the purpose. All asphalt pavements are kept in good repair. Of course in the spring after months of weather which is unsuitable for laying asphalt some of the older asphalt pavements are badly out of repair, but during the remainder of the season this is not the case.

It may be of interest to note here that during 1904 asphalt pavements

1	year	out	of	guarantee	cost	00.0¢	per	sq.	yd.	for	repairs.
2	years	"	"	"	"	2.8	"	"	"	"	"
3	"	"	"	"	"	1.6	"	"	"	"	"
4	"	"	"	"	"	4.9	"	"	"	"	"
5	"	"	"	"	"	3.5	"	"	"	"	"
6	"	"	"	"	"	5.2	"	"	"	"	"
7	"	"	"	"	"	4.3	"	"	"	"	"
8	"	"	"	"	"	10.1	"	"	"	"	"
9	"	"	"	"	"	4.0	"	"	"	"	"
10	"	"	"	"	"	9.9	"	"	"	"	"
11	"	"	"	"	"	13.6	"	"	"	"	"
12	"	"	"	"	"	19.0	"	"	"	"	"

All other pavements out of guarantee are repaired by

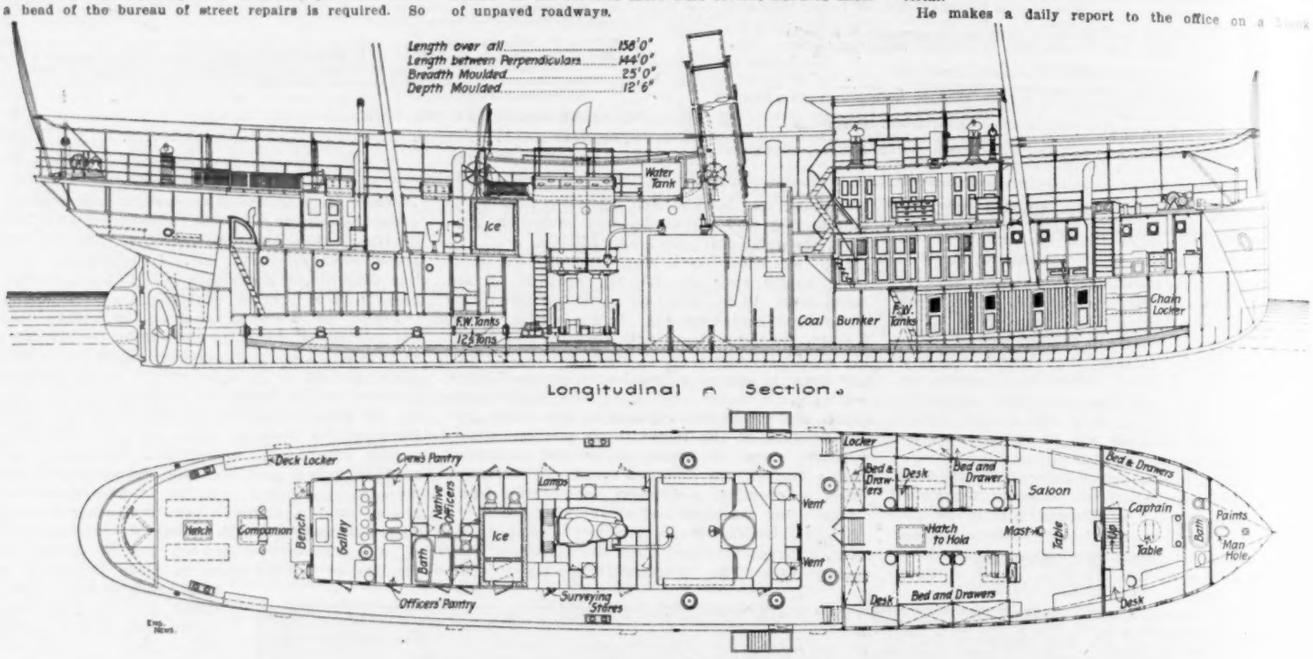


FIG. 2. LONGITUDINAL SECTION AND MAIN DECK PLAN OF COAST SURVEY STEAMER "FATHOMER."

REPORT OF REPAIRS TO ASPHALT PAVEMENT on .....

between ..... and ..... on 190

	Total Amount Laid	Laid between tracks and Two Feet Outside
Binder	.....loads, ...cu. ft.;	.....cu. ft.
Wearing surface after cutting out,	.....loads, ...cu. ft.;	.....cu. ft.
Wearing surface after using burner,	.....loads, ...cu. ft.;	.....cu. ft.
Standard asphalt pavement,	.....sq. yds.;	.....sq. yds.
Concrete foundation,	.....cu. yds.;	.....cu. yds.

Tempe ature of asphalt, highest, ...lowest, ...

Remarks .....

.....

..... Inspector.

*A Paper Read Before the Montreal Meeting of the American Society of Municipal Improvements, Sept. 5 to 12, 1905.

†Assistant Engineer of Highways, Brooklyn, N. Y.

men employed by the city who are organized into gangs of suitable size, and provided with the necessary tools and materials.

In the built-up portion of the borough, where nearly all of the pavements except macadam are laid, the repair force during the summer months consists of five large gangs of men containing each

1	Foreman	at	$4.00	per day
4	Pavers	"	3.84	" "
2	Rammers	"	2.00	" "
13	Laborers	"	3.50	" "
4	Horses and carts	"	3.50	" "
1	Horse and wagon	"	3.75	" "
1	Team and truck	"	5.00	" "
	Total		$80.27	

Two small gangs of men containing each

1	Foreman	at	$4.00	per day
2	Pavers	"	4.00	" "
1	Rammer	"	3.84	" "
6	Laborers	"	2.00	" "
3	Horses and carts	"	3.50	" "
1	Horse and wagon	"	3.75	" "
	Total		$44.01	

One street cleaning gang containing

1	Foreman	at	$4.00	per day
6	Laborers	"	2.00	" "
5	Teams and trucks	"	5.00	" "
1	Horse and wagon	"	3.75	" "
	Total		$44.75	

Nine sidewalk repair gangs containing each

1	Flagger and curbsetter		$4.50	per day
1	Helper		2.00	" "
1	Horse and wagon		3.75	" "
	Total		$10.25	

In addition to the above force one gang of men is constantly employed with concrete mixer laying cement sidewalks and concrete foundations for pavements. This gang consists of

1	Foreman	at	$4.00	per day
8 to 25	Laborers	"	2.00	" "
6 to 10	Teams and trucks	"	5.00	" "
3	Cement workers	"	2.50	" "
	Total		$37.50 to $161.50	

depending upon the character of the work.

There are also six connection gangs containing each

1	Foreman	at	$4.00	per day
1	Paver	"	4.00	" "
1	Rammer	"	3.84	" "
3	Laborers	"	2.00	" "
1	Horse and wagon	"	3.75	" "
	Total		$22.55	

There are also

3	Assistant foremen	at	$4.50	per day
6	Watchmen	"	2.00	" "
1	General foreman	"	5.00	" "

who supervise repair work in the whole borough.

There are six corporation yards in this portion of the city where material, such as paving blocks, sand, broken stone, cement, paving pitch and tools and machines are stored for the use and convenience of these repair gangs. A watchman is stationed at each of these yards who keeps account of all material received and sent to each gang. He also keeps an account of all tools stored at the yard and charges each foreman with tools furnished to his gang. These tools must all be accounted for at the end of the season's work.

The book kept by the watchman is as follows:

(A blank form 12 x 5 ins. in size is headed "Bureau of Highways," etc., with date space, followed by "Foreman's Record of Material Received at Corporation Yard at ....19..." Below are six columns: (1) From Whom Received. (2) Material. (3) For What Purpose. (4) Quantity. (5) Condition-Quality. (6) Remarks. In the lower right-hand corner the word "Foreman" indicates place for signature.—Ed.)

The large repair gangs are engaged almost entirely in relaying block pavements that have become so badly out of repair that they cannot be put in good condition without relaying entirely. It has been found that a gang proportioned in this way works to the best advantage at this class of work. The average width of roadway is about 32 ft., and four pavers have plenty of room to work without interference. Two rammers are able to ram and otherwise adjust all the blocks that four pavers can lay. Of the 13 laborers, four are usually employed in barring out and removing the old blocks, three or four are employed in carrying blocks to the pavers and the remainder in picking and grading the earth foundation.

The repair gangs having two pavers are employed in making small repairs to block pavements. Where a pavement is in fair condition, having only here and there a hole or depression, or where only a small portion of the pavement must be relaid to put the street in good condition, a gang of this size can be employed to the best advantage because a larger one would be scattered so much that the foreman could not have proper control over all the men. The connection gangs are employed in restoring the pavement over openings made in block pavements for the purpose of making water, sewer, gas and electric connections. They also repair all dangerous holes reported to the office. Not all of the connection openings are restored in this way. The gas and electric companies are allowed to restore much of the pavement removed by them for this purpose and no charge except for inspection is made by the city for the privilege of making the openings.

A district comprising about one-sixth of the paved area of the borough is allotted to each connection foreman and his work is confined to that district almost exclusively.

Each paver is required to pave as a day's work 45 sq. yds. of granite blocks, or 45 sq. yds. of Belgian blocks, or 60 sq. yds. of cobblestone pavement. There is very little brick pavement in the borough and the wooden block and the greater portion of the asphalt block pavement is still under guarantee, so that the amount required for a day's work is not fixed.

The foreman makes a written report upon the following blank each day, giving the force employed, the amount of work done and the materials used.

(This blank is 14 x 8½ ins. Provision is made for dating it in the upper left-hand corner. The main heading reads, "Foreman's Daily Report Bureau of," etc. There are nine columns, providing for statements as to number and date of permit, kind of connection, location and class of work, square yards paved and loads of sand and of stone used. At the bottom of the blank there is a place for the foreman's signature.—Ed.)

This information is recorded in the office and the cost per square yard is figured as soon as the work is finished. Every foreman is thus kept in competition with every other foreman and expensive work is detected at once.

The area of pavement removed for a connection opening averages about 4.2 sq. yds. The connection gangs are required to move from place to place so constantly in their work that they are not able to restore as much pavement as if this were not the case. The average day's work for one of these gangs is ten openings or about 42 sq. yds. of pavement.

The method followed in making and restoring these openings is as follows: The plumber obtains the necessary permit for making the connection from the proper department and pays the regular fee. He then obtains a permit from the Bureau of Highways to open the pavement and pays the fee required for restoring it. This money as it accumulates is kept as a separate fund and is spent for the wages of the men employed to restore the pavement. A report is made to the Bureau of Highways after each connection opening is made by the department, or bureau which granted the original permit. Ten days after the opening is made an order to repave it is given to the foreman in whose district it happens to be.

This method of procedure has been so well systematized that not more than 2 or 3 openings out of 12,000 per year fail of being repaired promptly. The foreman returns the list of connection openings paved each day in a daily report. A permanent record is then made of the location of the opening, the date when made and when repaired, by whom made, etc.

Reports are made daily by the Departments of Police and Street Cleaning of all holes in the pavement, dangerous or otherwise, which have been found by employees of these departments and they are given to foremen of connection gangs to repair. These foremen communicate with the office every day by telephone at a given hour for the purpose of receiving notice of such holes and for other purposes. Several thousands of holes are repaired in this way each year. It is customary to repair them within 24 hours from the time they are received at the office. They occur in great numbers over all trenches and connection openings. More than 100 are commonly reported after a heavy storm.

During the winter months all of the repair gangs are laid off and the connection gangs are doubled in number. They are employed in making temporary repairs to dangerous holes, sprinkling sand on icy walks and pavements, cleaning snow and ice from walks in front of city property, cleaning suburban roads after storms, providing surface drainage as far as possible where no sewers have been built and doing a multitude of things for which they seem to be most available. The street cleaning gang follows the repair gang and after an interval of 15 days from the time repairs are made cleans away the sand with which the newly laid pavement has been covered.

Up to the present time almost all the pavements laid with a concrete foundation are so new that only slight repairs are necessary. The repair gangs therefore are engaged almost entirely with the old granite block, Belgian block and cobblestone pavements. The present organization of the gang need not be greatly changed, however, when these old pavements are entirely replaced, as we may reasonably predict that they will be in a few years.

The flaggers are employed in making repairs to curb, crosswalks and flagging. They make daily reports to the office and are held to strict account for the quantity and quality of work which they do.

During the winter months a small stone crusher is operated at one of the corporation yards and a good supply of broken stone for concrete foundations for pavements and sidewalks is at hand in the spring. The cost of crushing this stone has been about 60 cts. per cu. yd. Contractors are required to deliver free of charge at the nearest corporation yard any old material required by the city. A large quantity of second-hand blocks, bricks and cobblestone is in this way usually hauled to these yards for use in repairs and for crushing. In a few years when the old pavements have been entirely replaced this crusher will no longer be of use.

In 1903 a little more than 30,000 sq. yds. of granite block pavement on a concrete foundation was laid by the repair force in place of old cobble pavement which was removed. The cobblestones were hauled to the crusher and crushed and used in the concrete foundation. The granite used came from nearby streets that were being paved with asphalt and were delivered by the contractor without cost to the city. Sand was delivered on the street by contract at a price per cubic yard. The cost of this work was $2.10 per sq. yd. When new blocks were used this cost was $3.54 per sq. yd. The average cost of such work done by contract in the same year was $3.56 per sq. yd. Some work of this kind was done the following season, but usually the saving over the results obtained by contract, if there is any, is so small and the appropriations for contract work have been so liberal that it has seemed wiser to expend all money appropriated for repairs proper and not for repaving.

It should be mentioned, in comparing the cost of this work when done by contract and when done by day's labor, that the contractor pays $1.50 for ten hours of labor, while the city pays $2 for eight hours' labor. Then, too, the contractor chooses his own men, while the engineer in charge of such work takes the men, teams, etc., that are sent to him without discretion. The city buys its material such as cement, sand, etc., by contract, frequently when the market is unfavorable, while the contractor buys at his convenience when the market is favorable, and can almost invariably obtain lower prices. The difference in these items should be sufficient for a handsome profit to the contractor.

In the suburban portion of the borough the repair force consists of

(A) Four gangs of men containing each

1	Foreman	at	$4.00	per day
8	Laborers	"	2.00	" "
1	Horse and wagon	"	3.75	" "
4	Horses and carts	"	3.50	" "
2	Teams and trucks	"	5.00	" "
	Total		$47.50	

(B) Two gangs of men containing each

1	Foreman	at	$4.00	per day
10	Laborers	"	2.00	" "
1	Horse and wagon	"	3.75	" "
4	Teams and trucks	"	5.00	" "
4	Horses and carts	"	3.50	" "
	Total		$61.75	

(C) Three gangs of men containing each

1	Foreman	at	$4.00	per day
12	Laborers	"	2.00	" "
1	Horse and wagon	"	3.75	" "
3	Horses and carts	"	3.50	" "
1	Steam roller engine	"	3.50	" "
1	Team and sprinkling cart	"	5.00	" "
	Total		$50.75	

(D)

1	Assistant foreman	at	$3.00	per day
22	Teams with sprinkling carts	"	5.00	" "
	Total		$113.00	

One assistant general foreman at $4.50 per day has immediate supervision of this suburban force.

The four repair gangs first mentioned are employed entirely in repairing dirt roads and are provided with an ordinary blade road machine. This machine is hauled by two teams and, when the soil is free from stone and tough sod, should be able to repair 1,000 ft. of roadway per day. The laborers are then only required to make what small repairs the machine neglects, clean and grade the gutters and to dispose of sod and other debris. Much of the work of these gangs, however, is filling holes and washouts and doing small jobs of grading when the machine is of no use, so that the average amount of roadway repaired per day is much less than 1,000 ft.

The two gangs designated (B) are employed in cleaning macadam pavements. They are each provided with an A. B. C. macadam scraper and a street sweeping machine. The linear feet of roadway one of these gangs cleans per day depends entirely upon its condition and the width of roadway, the length of haul for the sweepings, etc., so that no fixed amount constitutes a day's work. In the most remote and unfrequented portions of the borough the macadam pavements are not cleaned more than twice per season. In the best part of the suburbs they are cleaned once per week. Where the roadway is provided with a curb they are swept and cleaned much as any other pavement is cleaned, but where no curb is set the grass and weeds are cut up with a road machine and the gutter is graded only.

The three gangs designated (C) are employed each with a steam roller in making repairs to macadam pavements. The macadam roads—the only paved highways in the suburbs—were, many of them, paved several years ago with limestone, and as they become quite thoroughly worn out they are resurfaced with trap rock. Contracts are let each winter for this material at a price per cubic yard delivered on the street. This price for the last

few seasons has averaged about $1.65 per cu. yd. 27,900 cu. yds. of 1½-in. broken stone and screenings were bought for this work in 1905, which it is thought will repave about 11 miles of roadway. A gang organized as above should finish at most about 500 sq. yds. per day. The gang usually works about as follows: 5 or 6 men are required to spread stone, two (2) men with horse and cart each are required to spread screenings, and the remaining men and horses and carts are required to clean and prepare the roadway to receive the stone. The cost of this work is usually about 9 cts. per sq. yd. per inch in depth of finished work. This compares very favorably in price with the results obtained by contract and the quality of the pavement obtained is fully as good as can be obtained in any other way, so that the policy of the bureau of owning its own steam rollers and doing its own macadam repair work has proved to be a complete success.

Eighteen sprinkling carts owned by the bureau and under the supervision of an assistant foreman are employed in sprinkling macadam roads. Only a part of these roads, the most frequented thoroughfares and those in the most closely built-up districts, can be sprinkled by this number of carts.

A certain length of roadway is allotted to each sprinkling cart and the driver is held responsible for the condition of this roadway. It is considered that one cart is able to sprinkle properly about two miles of roadway 15 or 18 ft. in width, if hydrants are located at points convenient to the work. In a working day of eight hours one cart should deliver at least 35 loads of water of 600 gallons each upon the street. If the team walks at a reasonable speed, one cart load should cover about 600 ft. In those portions of the suburbs that are highly improved the roadways are much wider than 18 ft. and must be sprinkled several times per day in order to lay the dust completely. This sprinkling is continued for about 200 days per season. Outside of the comfort afforded the residents, who otherwise would be very unhappy and uncomfortable, because of the dust, it is undoubtedly of great benefit to the pavements themselves as they would ravel and deteriorate rapidly from traffic were they not sprinkled. The foreman in charge of this work is provided with a bicycle and visits each sprinkling wagon at least twice each day.

The general foreman who, under the direction of the assistant engineer in charge of street repairs, has charge of all of the repair force, is provided with a horse and carriage and spends all of his time practically supervising the work in the streets. He is able to visit every gang of men about every two days.

Each assistant general foreman has charge (under the general foreman) of repairs in a certain district. He is supposed to be thoroughly familiar with the condition of the pavement on every street in his district, and is held responsible for the amount and character of work done by repair gangs in that district. It is his duty also to locate and repair promptly all defects in the pavement that have escaped the attention of the police and street cleaners. The assistant engineer in charge is provided with a small automobile and chauffeur to care for it. This machine has proved to be more efficient than and economical than horses for this work, and more of them will no doubt be introduced in other departments for work requiring much travel.

Weekly, quarterly and yearly reports are made to the chief engineer and by him to the commissioner of public works of the operations of this division of the bureau.

Including the fund accumulated from charges for plumbers' and corporation openings, the amount annually appropriated for labor maintenance and supplies for the Bureau of Highways is about $485,000. A large part of this (about $300,000) is spent for the purpose of street repairs. A few years ago when cobblestones formed the great majority of all the pavements, this sum was entirely insufficient to keep them in repair. Where traffic was heavy they could not be made to stay in repair any length of time and almost any amount of money could be spent in the effort to put them in good condition. Recent large bond issues by the city for repaving have nearly transformed the borough from one of the worst paved cities in the world to one of the best, and have enabled the bureau with this appropriation to put the remaining old pavements in good condition.

The problem of street repairs would be greatly simplified if the pavements were not constantly torn up by corporations for the purpose of laying gas mains and connections, electric light and telephone conduits, repaving street car tracks and cables and by contractors for the purpose of laying water mains and sewers; by plumbers for the purpose of making water, sewer and gas connections and by others for almost every conceivable purpose.

In 1904, 78,272 connection openings of all kinds and 37 miles of trenches for water mains alone were opened in the paved streets. The length of trenches opened by gas companies, sewer contractors, electric and other companies is not exactly known, but it was very large. These trenches and openings are seldom properly when they are refilled and invariably settle unless to destroy the smooth surface of the pavement, and no matter how carefully the repairs are made the pavement is never as good as it was originally. After a few years have been dug through it, it must be entirely rebuilt to restore it to its former condition.

Legitimate wear from the wheels of vehicles and the feet of horses is not in most cases the greatest factor in the destruction of a good pavement.

The day when all or nearly all subsurface structures in the borough or the city may be placed in conduits built for that purpose seems far off and the sub-surface of the streets bids fair to become more and more closely occupied by such structures until, as at present in some parts of Manhattan, it is a difficult problem to find room for more.

Its value in use is the only true measure of the worth of a pavement. This value depends nearly as much upon the state of repair in which it is kept as upon the manner in which it is built. It is certainly less expensive to keep pavements in good than in poor condition and their life will be much longer.

Few things improve the general appearance of a city more and give a better general impression than nicely paved streets. The condition of the pavement is something of an index to the character of the people. It has a direct bearing upon their physical, mental and moral welfare. It is noticeable that after a new, clean pavement has been laid, people are more careful of their personal appearance and the children become more addicted to the use of soap and water.

As in other undertakings good work implies good organization. The laying of a modern pavement requires some skill and this skill is acquired only by experience. A system of civil service which insures reasonably continuous employment is therefore necessary. If every man is given a living interest in his work and made to feel the importance of it, the question of organization is easily solved.

The above organization is not submitted as an example of a perfect one or one that would be suitable for all cities of this size. It is no doubt capable of improvement, but it has proven sufficient for its purpose in Brooklyn, and its members quite generally feel that their occupation is a desirable one and that they are doing an essential and important part in providing the

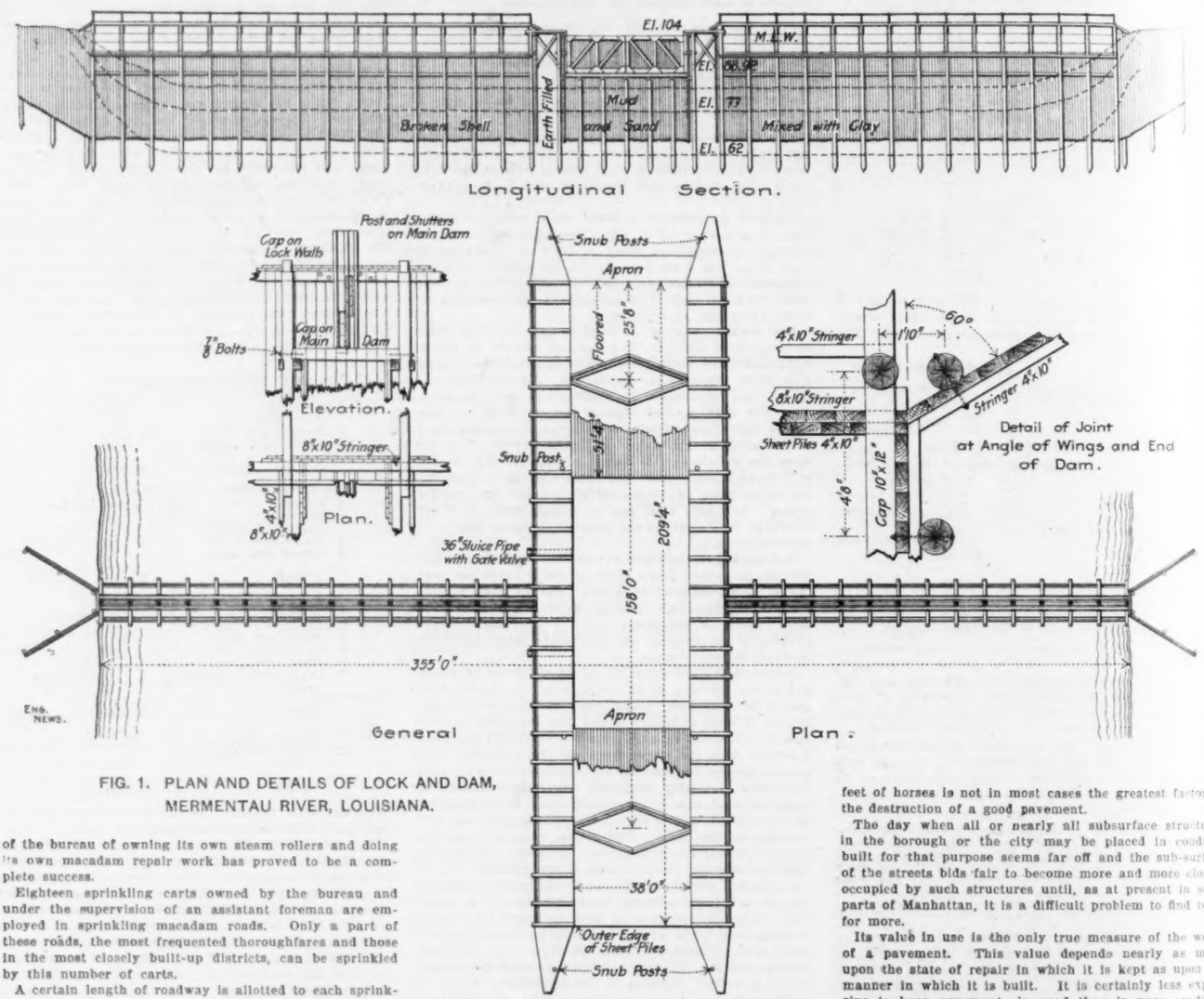


FIG. 1. PLAN AND DETAILS OF LOCK AND DAM, MERMENTAU RIVER, LOUISIANA.

modern facilities and wholesome surroundings that science decrees to be necessary to preserve the intellectual and physical stamina of the race as the movement of population toward the cities steadily increases.

Assistant Engineer in Charge.	Chief Clerk.		1 foreman, 4 pavers, 2 Rammers, 13 laborers, 4 horses and carts, 1 team and truck, 1 horse and wagon.
	Complaint Clerk.	5 repair gangs	
	Record Clerk.	2 repair gangs.	1 foreman, 2 pavers, 1 rammer, 6 laborers, 3 horses and carts, 1 horse and wagon.
	Pay Roll Clerk.	1 street cleaning gang.	1 foreman, 6 laborers, 5 teams and trucks, 3 horses and carts, 1 horse and wagon.
	Assistant General Foreman.	1 sidewalk repair gang.	1 foreman, 10 laborers, 4 teams and trucks, 2 horses and carts, 1 horse and wagon.
	Assistant General Foreman.	6 connection gangs.	1 foreman, 1 paver, 1 rammer, 3 laborers, 1 horse and wagon.
	General Foreman.	5 material yards.	1 watchman, 1 laborer.
	Assistant General Foreman.	3 macadam repair gangs.	1 foreman, 1 steam roller eng'r, 14 laborers, 1 horse and wagon, 4 horses and carts, 1 team and sprinkling cart.
	Assistant General Foreman.	2 macadam cleaning gangs.	1 foreman, 10 laborers, 2 teams and trucks, 4 horses and carts, 1 horse and wagon.
	Assistant Engineer.	4 repair gangs, dirt roads.	1 foreman, 6 laborers, 1 horse and wagon, 2 teams and trucks, 3 horses and carts.
		18 sprinkling carts.	1 foreman, 18 laborers.
		2 material yards.	1 watchman, 1 laborer.

Total force when recruited to its full strength and including all men assigned to special work and not shown above about 500.

TELEGRAPH COMMUNICATION IN ALASKA includes, in connection with the 1,100-mile cable from Seattle, Wash., to Sitka, Alaska, a series of branch cables radiating from Sitka which aggregate 1,100 miles in length. There are also several thousand miles of land telegraph lines, including a line from Sitka to Dawson City and a line down the Yukon to the coast. A wireless service connects St. Michaels with the mainland, 100 miles. This entire system was installed by the Signal Service of the U. S. Army.

MOVABLE DAM AND LOCK OF THE RICE IRRIGATION AND IMPROVEMENT ASSOCIATION, MERMENTAU RIVER, LA.

The Mermentau River and its tributaries furnishes water for the irrigation of about 250,000 acres of rice land, surrounding Crowley, in Southwestern Louisiana.

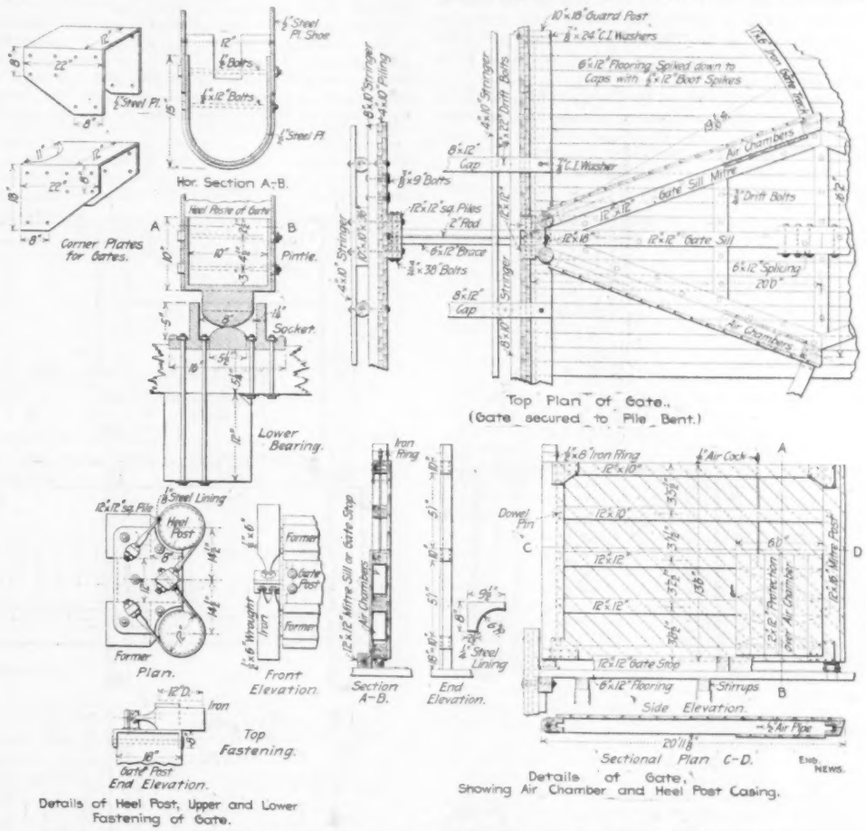


FIG. 3. DETAILS OF LOCK GATES AND GATE SUPPORTS, MERMENTAU DAM.

The pumping season for rice begins about the middle of May and continues incessantly for about one hundred days, through what is generally the period of least rainfall.

Rice irrigation is not only very intense, but the methods employed are wasteful, requiring more water than is necessary. At present the allowance is about 15,000 gallons per acre day, or a water duty of about 50 acres per second foot. On this basis, the requirements of 250,000 acres of rice would be nearly 6,000 sec. ft. of water for 100 pumping days.

The lower 90 miles of the Mermentau River runs through a very low marshy country, having an average fall of 0.05 ft. per mile. As the season of low rainfall and the maximum draft of the pumps are coincident, the salt water from the Gulf of Mexico flow back into the pump intakes of the several canals feeding from the river, thus not only blighting the growing crops, but also sterilizing the soil for the production of the next season.

This was such a menace to the rice industry of that section that on Nov. 21, 1902, the Rice Irrigation & Improvement Association was organized for the purpose of outlining ways and means to prevent the recurrence of these disasters. Immediately after organization, the association called in Mr. Jno. W. Maxcy, consulting engineer, Houston, Texas, to make the necessary investigations and devise plans that would effectually shut out the salt water, as well as prevent the danger of overflow to the contiguous low lands.

The movable dam and lock, as herein illustrated, was decided upon and was designed in detail by Messrs. Maxcy & Anderson, of Houston. The plans were approved by the U. S. Secretary of War, and the entire work was done under the supervision of the firm named just above. We are indebted to Mr. Maxcy for material used in preparing this illustrated description of the structure. The plan and elevation, Fig. 1, shows the general design and dimensions of the dam and lock.

The movable shutters may be set at high tides, or low river stages, to prevent the passage of salt water up the river, while during high water in the river they may be opened, and thus prevent flooding the adjacent low lands. The whole structure was built of pine lumber, treated with not less than 18 lbs of creosote per cu. ft. All lumber was dressed, sized and cut to fit at the creosote works before treating, thus leaving no exposed surfaces for the action of the toredo.

The first pile on the temporary dam was driven on May 30, 1903, after salt water began to go up

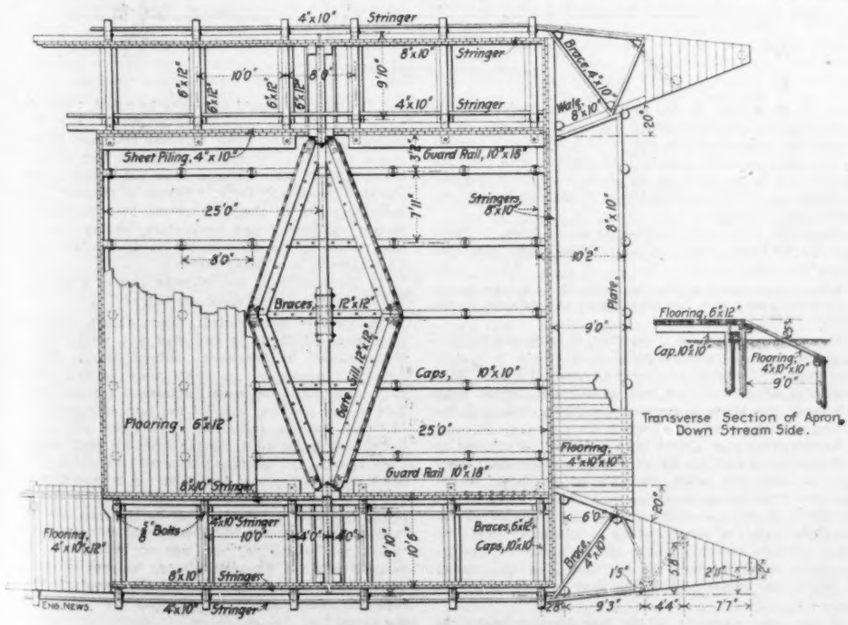


FIG. 2. ENLARGED PLAN OF GATE END OF LOCK.

the river, at a time when the rice was tender and very susceptible to saline influence. By rushing the work the temporary dam was closed on June 18, saving the rice crop of that season. The same temporary structure did service in saving the rice crop of 1904, and as the permanent structure was completed Oct. 12, 1904, it will do service for this year's and subsequent crops.

An enlarged plan of the gate end of the lock is shown by Fig. 2, and details of the gates and gate supports by Fig. 3. The movable dam is provided with two vertical shutters, Fig. 4, operated by a gearing shown by Fig. 5.

The work was first let by contract, but owing to its inaccessibility and other causes, the contractors failed. It was then taken up by the forces of the Improvement Association and finished under many difficulties arising from its distance from labor and material centers, all of which added to the cost of the structure, which amounted to about $125,000.

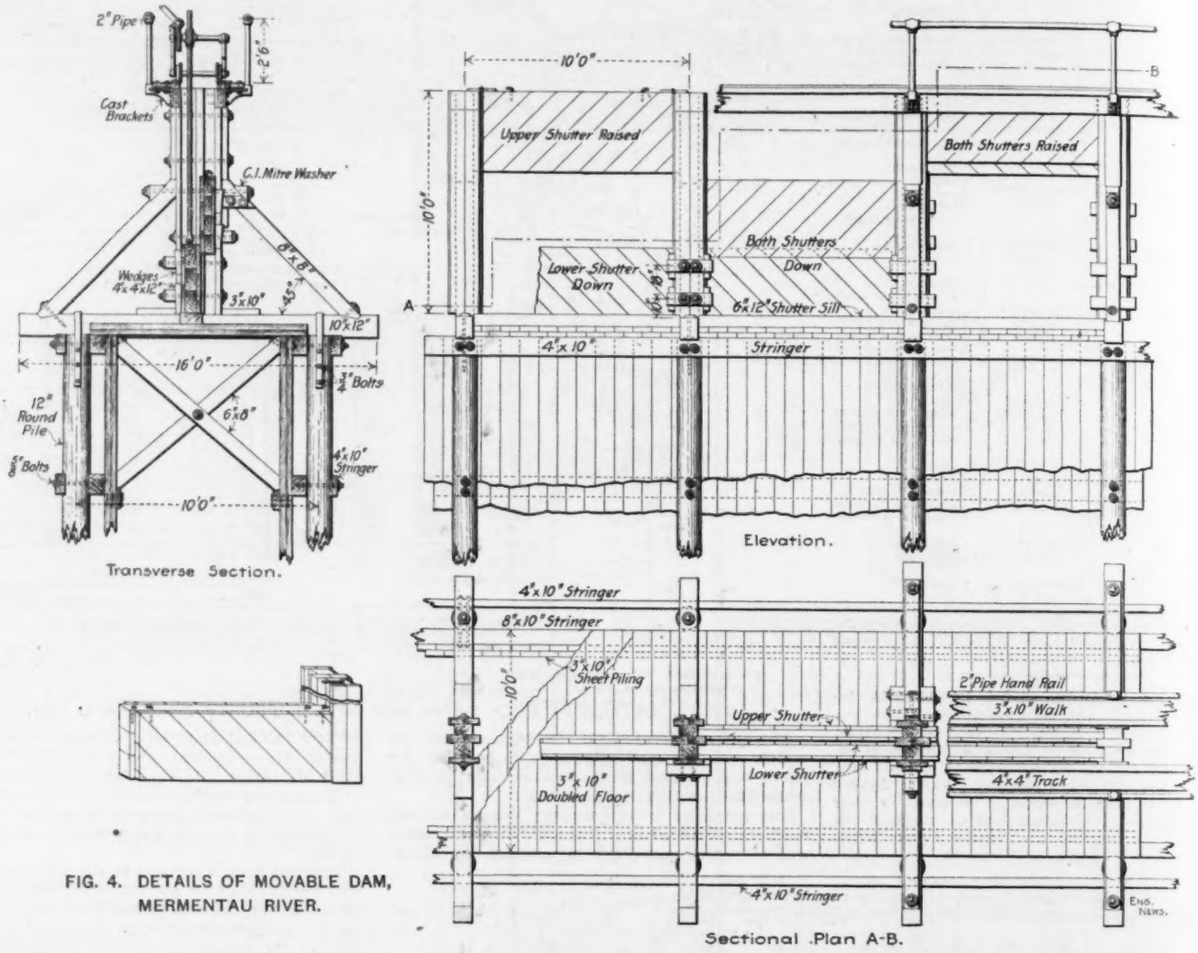


FIG. 4. DETAILS OF MOVABLE DAM, MERMENTAU RIVER.

OPERATION OF A SINGLE-TRACK RAILWAY UNDER THE AUTOMATIC BLOCK SYSTEM.*

By H. M. Waite.†

For ten years we have been automatically blocking our railway line. As a result we claim we can operate 30% more trains than before it was so blocked. This can be figured as follows: Originally, under an operator's block, trains were blocked 4 to 5 miles apart. In that distance we now have three automatic blocks, which means that three trains can move in that same distance, following one another, where previously only one could move. Taking all conditions and delays from increased number of trains into consideration, we figure that an increased handling of 30% is a very conservative figure.

While our present standard signal is the gas semaphore, we are operating all kinds, from the old clockwork down to the present gas semaphore and storage battery. So much depends on the installation of the signals that I will cover that phase more closely. The signals should be placed so as to have a signal at each switch for a starting signal. The block should be from 1 to 1½ miles in length, but never longer than 1½ miles. Greater efficiency can be had by staggering the signals; that is, instead of putting the home signals opposite to one another, as was always done in the original installations, place one home signal inside the block, so to speak, giving that much more head on protection.

Another point to be borne in mind is the proper location of the "overlaps;" that is, the placing of the setting point of one of the signals of the block outside the block limits, making it impossible for two trains to enter a block simultaneously from opposite directions. The "overlap" should be so placed on grades to give the advantage or protection to the down coming train, and be kept outside the switches of passenger sidings. They should be marked plainly and be of a noticeable character, so that trainmen may become familiar with their location and know to which signal to send their flagman to bring trains through the block, in case of breakdowns inside the "overlap."

There has been some controversy as to delay to trains meeting at points inside of block limits. Our rule covering this point reads:

When trains meet within the limits of a block the inferior train may pass the stop signal and proceed to the siding under control.

This rule permits the dispatcher to give the inferior train the best of a meeting point, so it will be in to clear and the superior train will receive a proceed signal. Each switch is supplied with a bell annunciator, which rings whenever the block is occupied, notifying trains in the siding that the block is occupied.

Each home signal should have a distant signal, but as the expense of such an installation is much greater, they can be used only when the view of the home is obscured. The setting point for each signal is placed 140 to 250 ft. in advance of it, according to the kind of signal; this point is designated by a triangular cast iron sign, marked "electric clock signal." As we operate normally clear, it gives the engineman an opportunity to see if the signal goes to the stop position before he passes it.

If the home signal is in the stop position before the train enters the block, or indicates proceed, and does not change to stop before the train reaches the signal, the train must immediately stop, send a flag ahead, wait five minutes and proceed under full control, until the obstruction is reached or the train passes out of the block. The block signal circuit extends to the clearance post on all sidings; therefore, any car or train not in the clear will hold the signals in stop position. Our passenger trains carry a speeder in the baggage car, and, when stopped by an automatic signal, it is immediately put on the track and the baggagemaster is sent ahead on the speeder with danger signals, thus greatly reducing the delay. Our block failures average .015 to every 100 train movements.

I mentioned in the early part of this paper that flagging becomes a matter of form with the absolute block, and the question would naturally be asked, "How do you know that the men observe the automatic signal?" I can answer simply: We know they are respected from experience and tests. Some time since we had an accident, which proved that the men were not always respecting signals. Same old story, "Taking a chance." Letters were sent out to about 20 of the best passenger and freight enginemen and conductors, calling their attention to an article on surprise checks on another line. This question was asked them:

"In your opinion, are surprise checks a good thing, and do you consider them necessary?"

The answers were varied. Some of the men thought tests were all right, as any man who would run a red signal should be dismissed. Others thought they were unjust, unnecessary, etc. All were notified, however, that tests would be made, automatic signals would be held in stop position, one and two torpedoes placed on the rail, and burning fuses displayed, lights put out. Reports were made on a regular form for each test. If a man openly and grossly disobeyed the rules, ran the block or fuses, he was dismissed. If he was slow in reducing speed, did not whistle out a flag or call it in promptly, he was taken out of service and sent to the "train rule examiner" to be examined on the rules. This "train rule examiner," by way of explanation, examines all men for promotion, holds lectures on the rules three times each week, attends all investigations, and sees that all employes in the train service understand the rules.

*Abstract of a paper read at the annual meeting of the Central Association of Railway Officers.

†Division Superintendent, Cincinnati Southern Ry., Lexington, Ky.

There are many conditions that vary the cost of the automatic block installation, but roughly we may say that on blocks 1½ miles long, each semaphore signal installed costs $700, or $1,400 for a block of two home signals, or $2,600 for a block of two home and two distant signals. The disc signals cost, installed, about $900 per signal, or $1,200 for a block of two home signals, and $2,250 for a block of two home and two distant signals. If the blocks are made 1½ miles long, the semaphore will cost $600 per mile and the disc $800 per mile, where two home signals are used. The average cost of maintenance per signal per month for semaphores is $10.40; discs, $8.50. The average cost of maintenance per mile of track protected per month—semaphore $14.90; discs, $10.70.

We use gravity battery on line and track, potash and storage on motors: 16 potash cells to each motor; four storage cells to each motor; four to 12 line cells to each signal; four to eight track cells to each signal; potash batteries are replenished every 18 months. All batteries are placed in concrete tubs under ground. Cost of renewals: Potash renewals, 16 cells, $14.52; line batteries, 10 cells, $1.50; track battery, eight cells, $1.25.

Our signal department is organized as follows: A superintendent of signals has general supervision of the automatic signals, interlockings, telephones, etc., and the maintaining and establishing of all standards. He reports to the general manager. Each division has a signal engineer, who reports to the division superintendent. Under him are two foremen, one for each district, who have direct charge of all inspectors and gang foremen working on their respective districts. Each inspector has an average of 18 signals and 8 to 12 miles of track.

The question is asked: "Is it worth the expense?" Unfortunately, we can not say how many dollars the signals have actually saved—no one can; but the old stories of three collisions a day, and now none, the actual experience of trains saved from collisions, etc., make us believe the money is well spent; and to prove it, we are spending more every day for new installations and improvements on the old.

We may have our own opinion, but that of others is always comforting, and I will quote as follows from the "Railway Age" of April 28, 1905:

> It is not an exaggeration to say that, for safety of method, combined with simplicity of operation, the 336 miles from Cincinnati to Chattanooga is not equaled or even approached on any other railway in the United States, and probably not in the world. It is an object lesson for those who wish to know, as well as those who ought to know, what can and should be accomplished on the railways of the United States toward securing the safety to their trains.

In some places on the line we have installed the electric train staff, and for certain operations—gauntlets through tunnels or over bridges or between double tracks—it is as near perfect for safety as can be had; but for high speed it is cumbersome, when it comes to picking up and delivering the staff. By means of rubber hose hoops we can pick up a staff at 40 miles per hour, and by a catcher on the engines of some of our fast trains we pick it up at 60 miles per hour, but you can see from this that for continuous blocking the staff would cause delays and is cumbersome. Train orders are not needed where you have the electric train staff. We operate the staff on a single track bridge over the Ohio River between two yards, with 100 train movements in 24 hours, and not a train order is sent; for such places it is unequaled.

STRUCTURAL STEEL DAMS.*

By F. H. Bainbridge.†

The writer first became interested in the subject of steel dams in 1893, making (for his own information) estimates on a great number of different types of structures. The subject had previously been considered to a limited extent both in Europe and in this country. In 1893 a committee reporting on the Quaker Bridge dam, stated that a steel structure would be economical and safe, but that it would not give that idea of permanence which should attach to the water supply of a great city like New York. In 1894 the Consolidated Water & Power Co., of Redlands, Cal., proposed to dam the Santa Ana River at its junction with Bear Creek in San Bernardino County. At this location the canyon is narrow, with nearly vertical sides of granite for a height of 200 ft. above the bed of the stream. The proposed height of dam was 210 ft. The writer made for this company preliminary plans and estimates on a steel dam 210 ft. high, consisting of a series of horizontal arched ribs of 105 ft. radius, faced with steel plate. This project was favorably reported on by a commission of engineers, including Mr. W. W. Curtis and Mr. Henry Goldmark.

At that time, 1894 structural steel was as low as 1 ct. per lb. (Pittsburg), and the finished material correspondingly low. At the present time prices for structural material at Pittsburg are about 75% greater. On the other hand, in 1894, Portland cement cost about three times what it does at present. Had the relative values of steel and Portland cement in 1894 been maintained, the subject of steel dams would have received far greater attention than has been the case. Notwithstanding the adverse trend in prices there will still be found to be great economy in the use of steel for dams in many locations, as the following figures show.

For average conditions in our Western country the section of a masonry dam may be taken as equivalent in quantity to a section 8 ft. wide at the top and with a base of five-eighths the height. This gives for a dam 100 ft. in height an average of 1.3 cu. yds. of masonry or concrete per sq. ft. of cross section, which at $8 per cu. yd., gives $10.40 per sq. ft. of cross section. The weight of steel per sq. ft. of cross section will generally be found to be about 1.25 times the height of the section, or 125 lbs. for a height of 100 ft., and at 4½ cts. per lb. erected and painted, there will be a cost of $5.62 per sq. ft. of cross section.

Again it will be found that in most locations in our Western country where favorable sites for dams exist, a considerable haul by team from the nearest railway is necessary. Considering a cross section 100 ft. in height, and assuming 0.8 of a barrel of Portland cement to the cubic yard of rubble masonry, the weight of cement to be hauled will be 400 × 0.8 × 1.3 = 416 lbs. per sq. ft. of cross section, as against 125 lbs. of steel. I am assuming, in this comparison, that suitable sand and stone will be found at the site, which is seldom the case. For concrete the comparison is still more favorable to the steel.

It is usually assumed by the uninformed that stone structures subject to the action of air, water, and frost will last indefinitely. As a matter of fact only a small percentage of the stone which is accessible is at all fit for use in structures, and even in the best quarries, the inferior stone which must be wasted or used for riprap, often amounts to 50% or more of the stone quarried. In a dam, especially in cold climates, stone is subjected to most trying conditions and untried local stone should be used only with the greatest caution.

So far as our present experience goes Portland cement concrete for dams appears to be a safer material, but it must be remembered that concrete setting in air contracts in volume, and in large masses cracks are almost certain to result. For this reason concrete for large dams must first be cast in blocks and set in mortar joints after being dried out. Under certain conditions reinforced concrete for high dams appears to be a promising material, especially where an arched form is permissible, and its first use in this direction will be awaited with considerable interest. I am aware that a number of low dams have been built of reinforced concrete, but as questions of economy limit the use of steel to high dams, such only will be considered in this paper.

While stonework, in common acceptance, has an undeserved reputation for permanence and stability, steel has an equally undeserved reputation for deterioration. The reason for this is plain. Opportunities for observing the weathering of steel are most frequent in large cities where the air is laden with sulphuric and carbonic acid gases. Iron, water, rust, is usually looked upon as a necessary sequence, but my own observation on stand-pipes and dams built of steel is, that reasonably pure water alone has little effect in corroding steel, and that under water a good paint is a first-class protection.

The steel dam at Ash Fork, Arizona,* was completed in February, 1898. The steel work received one coat of raw linseed oil in the shop and one coat of red lead and an additional coat of graphite paint after erection. When visited by the writer in the fall of 1902 it showed no evidence of rust either on the water face or on the back. The writer understands that it will be repainted for the first time since 1898 during the current year. So far as is known to the writer this was the first fixed metallic dam ever constructed.

The steel portion of the dam is 184 ft. long on top and the whole dam is about 300 ft. in length, including short masonry abutments at each end. Structurally it consists of a series of triangular steel bents resting on concrete foundations and carrying steel face plates on the inclined or upstream end. No spillway or waste weir is provided, the dam being designed to permit a flow of 6 ft. depth of water over the crest. Since its construction a maximum flow of 4 ft. has been observed. To prevent the overflow from undermining the foundations, loose rock is piled at the base to break the force of the falling water. However, overflow to any considerable extent is a matter of rare occurrence.

The structure is composed of alternate rigid and loose panels. The crest or apron plates which fit the braced panels between the bents are riveted to a curved angle which is riveted to the upper end of the curved plate, while in the unbraced panel this angle merely bears on the apron plate. By this means the forces which would result from longitudinal expansion and contraction and which would be fatal to the structure are avoided. The face of the dam is composed of steel plates ⅝-in. thick and 8 ft. 10⅝-ins. wide, riveted to the outer flanges of the inclined I-beams of the bents. The plates are mainly 8 ft. in length, curved to a radius of 7 ft. 6 ins., forming a series of gullies or channels down the face and leaving a flat portion which rests on and is riveted to the I-beams. The curved plates, however, do not extend into the concrete of the toe, but are replaced by flat plates in the bottom course, the bottom curved plates being dished.

When the framework was erected and the anchor bolts set, the face plates were riveted on except the lowest course in the five highest panels, which were left open to provide a waterway until the rest of the structure was caulked and painted. The remaining plates were then put in place and riveted and caulked as rapidly as possible. When the reservoir filled the steel structure was found to

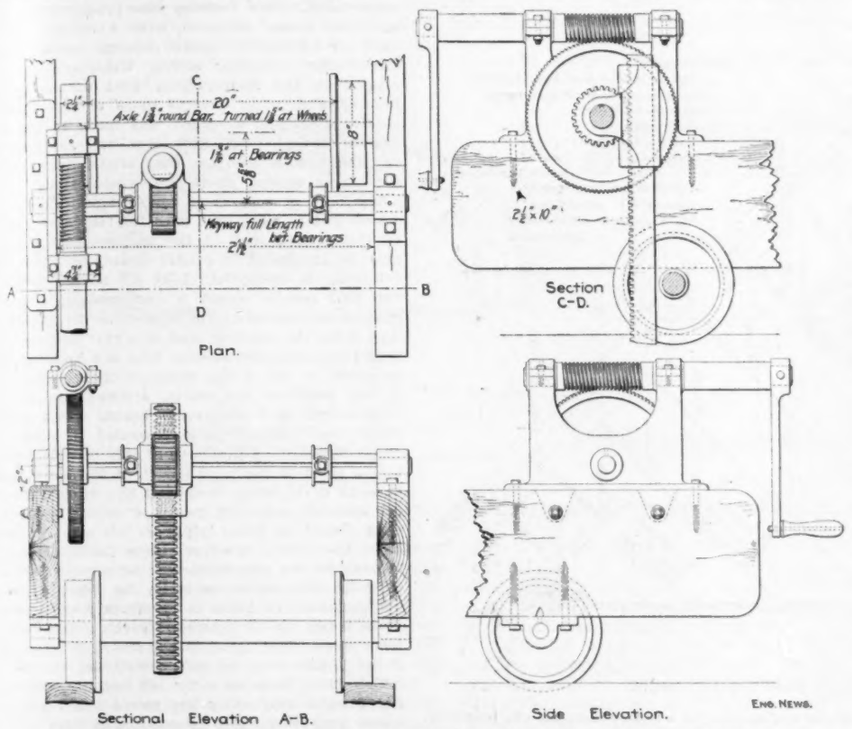


FIG. 5. DETAILS OF APPARATUS FOR HOISTING SHUTTERS OF MERMENTAU RIVER MOVABLE DAM.

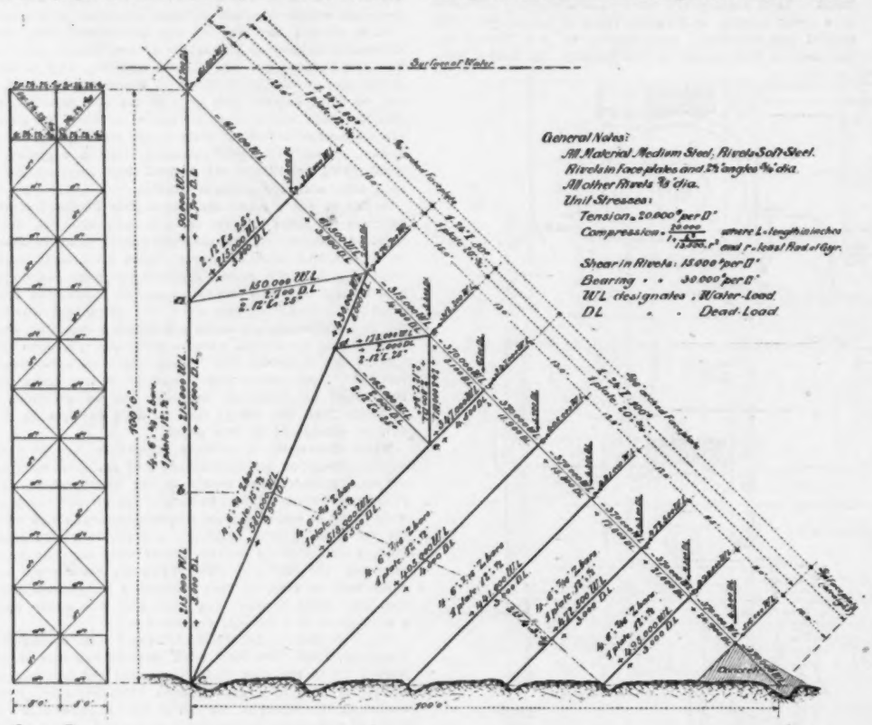
*Abstract of a paper presented at the meeting of the Western Society of Engineers, Chicago, Sept. 6, 1905.

†Principal Assistant Engineer, Chicago & Northwestern Ry., Chicago, Ill.

*Described and illustrated in Engineering News, May 12, 1898.—Ed.

be absolutely water tight, but some leaks developed in the concrete toe. In 1900 this concrete was covered with asphalt, and at the present time the entire structure is said to be absolutely water tight. This structure was designed by the writer in collaboration with Mr. James Dun, Chief Engineer, and Mr. A. F. Robinson, Bridge Engineer, of the Santa Fe system. Mr. W. D. Nicholson was Resident Engineer in charge of the work in the field.

The steel dam with concrete foundations at Redridge, Mich., was completed in the fall of 1901, and has since given satisfactory service.* It differs from the Ash Fork dam in that the weight of a concrete base furnishes the resistance to overturning and sliding, in place of anchorage to the bed rock as in the Ash Fork dam. This structure was proposed and designed by Mr. J. F. Jackson, who also had charge of the erection of the steel work of Ash Fork dam.


Sway Bracing
General Notes:
All Material Medium Steel, Rivets Soft Steel.
Rivets in Face plates and 2½ angles ⅞" dia.
All other Rivets ¾" dia.
Unit Stresses:
Tension 20,000 per □"
Compression = 20,000 − 70 L/r
Shear in Rivets: 15,000 per □"
Bearing . . 30,000 per □"
W.L designates Water-Load
D.L . . Dead-Load

TYPICAL BENT FOR A STEEL DAM 100 FT. HIGH.

The steel portion of the dam is 464 ft. long on the crest and consists of a series of steel bents, 8 ft. apart, to which is riveted a facing of steel plates. The face member is an I-beam. Riveted between the bents are ⅝-in. curved face plates, concave to the water, 7 ft. 6½ ins. wide over the chord, and having on each side a flat strip 5⅝ ins. wide, which is riveted to the flange of the I-beams. The radius of the curve is 7 ft. 5 7-16 ins. and the plates are 16 ft. long. Below the bottom course of curved plates is a course of flat plates, and the open space thus left is closed by an inclined diaphragm. The vertical joints are double riveted, the face plates lapping each other on the I-beams. The iron work is continued down the vertical face of the base with a 3-16-in. plate. All joints on the face are calked. Before and after erection the ⅝-in. face plates were given one coat of Edward Smith & Co.'s durable metal coating, and the facing plates, two coats after erection. All other parts of the structure were painted with graphite paint. This dam is not arranged to act as a weir, but a spillway with removable flash boards was provided at the west side of the reservoir.

As a study in economy in design and to show that this type of steel dam construction can be carried to much greater heights than has yet been done, the writer has prepared designs for a single section 100 ft. high and a stress sheet for one bent is given in the accompanying cut.

In the design of the Ash Fork dam the writer, complying with the wishes of the railway company's engineers, used low unit stresses and the minimum thickness of material was limited to ⅜-in. In the typical design here shown a minimum limit of ¼-in. thickness for material is used, and unit stresses are proposed corresponding with the general practice in stand-pipe and tank construction, a class of structure to which steel dams bear a close relation.

In the 42-ft. high bents of the Ash Fork dam, the average weight of metal per square foot of cross section was in the face plates and beams 50 lbs. per sq. ft., and in the struts and bracing 37 lbs. per sq. ft. Considerations of economy alone would in this case call for a steeper inclination to the face plates, but to reduce the required anchorage force to what it was deemed safe in seamy rock, an inclination of 45° for the face was used. In the typical design here shown of a 100-ft. high bent, the estimated weight of face plate and beams is 47 lbs. per sq. ft. of cross section and of struts and bracing, 79 lbs. For lower bents the weight of the face plates and beams per square foot will decrease very little, while the weight of the struts and bracing will decrease fast. Also, from general considerations it will be seen that as the inclination of the face plates is reduced below 45° the weight of the face plates and beams increasing faster than co-secant of the angles, will increase very fast, and the weight of the struts will also increase. From the above reasoning it is concluded that the angle of face plates with the horizontal should not be less than 45°.

Where the crest of the dam is not intended to be used as a weir the type of bent adopted in the Redridge dam will be found to be economical in weight. In designing the frame it is entirely possible to construct it so that the stresses produced by the water pressure will run back and forth through the frame, making a frame uneconomical in skeleton and producing a reduplication of joints expensive both in labor and material. A good rule to follow in designating the frame is to carry the pressures on the beams to the foundation in the most direct manner possible. The method of stress lengths proposed by Carl Bender, in studying economy in bridge design, is also equally well adapted to the study of frames for steel dams.

*Described and illustrated in Engineering News, Aug. 15, 1901.

THE EXPANSION AND CONTRACTION of concrete, due to temperature changes, was recently investigated by Sir Alexander R. Binnie, M. Inst. C. E., in the following manner as described by him in a discussion before the Institution of Civil Engineers in December, 1904.

The question arose—how did concrete expand and contract? In order to answer this question he had had constructed, a few years ago, a block of 4-to-1 granite concrete 100 ft. in length and 1 ft. square in cross-section, built to rest on rollers, so as to be free to expand in any direction. Proper verniers had been attached to either end, moving against pillars detached from the block itself. For three years, summer and winter, that block had expanded and contracted like an iron beam, with changes in the temperature. But the expansion and contraction had been found to be influenced also very considerably by the condition of the atmosphere; and in wet weather the expansion due to absorption of moisture was often as much as that due to summer heat. The action of the sun shining on one side of the block had also had a disturbing influence. Taking the average of all the conditions in various states of the weather, the expansion was 0.005226-in. for a rise in temperature of 1° F., for a block 100 ft. in length and 1 ft. square in cross-section. Assuming a maximum rise of temperature of 60° F., this would give an extension of 5-16-in. in 100 ft.; but he would not anticipate so considerable an extension in mass concrete of larger cross-sectional area.

THE NEW ROOF SHIELD FOR THE METROPOLITAN RAILWAY TUNNEL OF PARIS.

By R. Bonnin.*

The Metropolitan Railway of Paris, the greater part of whose length is underground, is composed of a tunnel whose roof is but little below the surface of the street. This tunnel, which is lined with a masonry arch, has two tracks. The arch is elliptical with a span of 7.10 m. (23.2 ft.) and a rise of 2.07 m. (6.79 ft.). It rests on masonry abutment connected by a masonry floor.

When the first line of the Metropolitan, the one running from the Vincennes gate on the East to the Maillot gate on the West of Paris, was under construction in 1898, the contractors for the different sections decided to build the roof of the tunnel with a shield, and to put in the abutment underneath. This decision was prompted by the excellent result obtained with a similar shield used for driving the tunnel through which passes the Clichy collecting sewer. Unfortunately the results on the Metropolitan were not so satisfactory and, after several more or less unsuccessful attempts, a return was made to the old system of timbering. This, then, was the method of construction used for the various lines which have been opened up to the present time.

The lack of success of the half section shield, which was to have been used for the construction of the arched roof of the Metropolitan tunnel, may be attributed to sundry causes of which the following is the chief: Like all similar shields, the half section shield is composed of a hood-shaped forward end, which shelters the workmen who drive the heading, and of a rear end, or tail, which protects the masons who are building the masonry of the arch. Between these two parts is the body of the shield, strongly braced by longitudinal and transverse beams which latter carry the hydraulic jacks intended to push the shield forward. The length of this body is generally a third of the total length of the shield, and through it the whole weight of the shield rests on the ground, either by means of rollers or sliding rails placed on joists lying on this same ground. In a few cases, however, these joists are made to rest on the abutments of the arch which are built in advance of the latter for this purpose.

The subsoil of Paris is far from homogeneous. It is made up of layers of earth, often hauled from some other point, in the midst of which are found blocks of stone and, sometimes, even walls which have been used for old buildings. Hence, the ground supporting the shield has rarely an equal resistance, and unequal settlement and a lowering of the shield are the result of this. Moreover, in moving forward, the shield carries with it, around its outside wall, a certain thickness of earth which, while causing at the level of the ground undulations which interfere with the movement of vehicles, is broken up at the same time and throws its entire weight on the tail end of the shield. Hence there is a tendency of the shield to raise at the forward end, and be pressed down at the rear onto the fresh masonry of the arch which may thus let go under the friction of the plates when the shield is moved forward. The use of the shield in ground so heterogeneous as that which forms the subsoil of Paris is a very difficult operation. This reason, added to other considerations, such as that of shields too hastily studied and with details which leave much to be desired, was the main cause of the lack of success of the half section shield of the Paris Metropolitan.

In a word, that which was especially wanting in the Paris shields was a supporting surface, sufficiently firm and uniform to avoid any settlement or longitudinal undulatory motion when the shield was moved. Messrs. Radenac and Raguet have introduced, on a new line of the Paris Metropolitan now under construction and of which they are the contractors, a new type of shield intended to avoid these troubles.

This shield is often advanced 6 meters for 24 hours, while the first shield gave at the most a mean of 3 meters advance in the same period. A few had even a less speed than this.

What characterizes mainly this new type of half-section shield is its mode of support. In-

*61 Rue Louis Blanc, Paris, France.

sted of resting, like the former ones, directly on the ground, it runs on a series of rollers set 70 m. apart in the direction of the longitudinal axis and arranged in parallel rows on the floor girders of the centers. The shield is supported in this way for a great part of its length, which makes its movement very steady. Settlements and undulatory movements are also reduced to a minimum. Settlements do not exceed 5 to 6 centimeters at most. The apparatus as shown in Figs. 1 and 2 is composed of three parts: the shield proper, the centers and the machinery.

THE SHIELD.—The shield is formed of an envelope of sheet steel, 15 mm. thick, having sensibly the shape of the extrados of the current tunnel of the Metropolitan. Sensibly is said, because the elliptical arch intended originally for the extrados of the current tunnel has been replaced by a semi-polygon having 19 sides. The skin is held by four cross beams shaped to a polygon, like the skin; the beams are connected by 38 girders of which 20 extend forward to strengthen the forward end, and 14 extend back to support the rear end. The total length of the skin is 7.5 m. In cross-section, the elliptical are inscribed in the outer polygon has a span of 8.32 m. and a rise of 1.94 m. (27.3 ft. and 6.36 ft., respectively). The bottom of the outer shell is 0.68 m. (=2.23 ft.) above the springing lines of the tunnel to be built. The outer shell of the forward end has the shape of a hood with four set backs on each side of the axis; each set back is stepped 0.30 m. (0.98 ft.) behind the one above it. The skin of the rear end has only two symmetrical set backs on each side of the axis and each of them is set back 1 m. (3.28 ft.). The skin is fastened to the girders by means of bolts, countersunk in the outer shell to give a smooth surface. The cross beams have a web 10 mm. (0.39 in.) thick, shaped on top to the form of the shell, and at bottom to a broken line sensibly parallel to the extrados of the arch of the tunnel and 0.2 m. (0.66 ft.) therefrom. This web is stiffened with angle irons $\frac{100\times100}{12}$ (=4×4×0.472 in.) and each cross girder transformed in this way to an I-beam is connected to its neighbors by means of longitudinal girders. The web is 315 mm. (=12.40 in.) at the center of the shield and 495 mm. (=19,488 in.) at the ends or the sides.

The longitudinal girders are formed of a web 10 mm. thick, stiffened by angle irons of $\frac{80\times80}{12}$ (=3.15×3.15×0.472 in.) on one side only. They are connected together in two's by transverse beams and form in this way 19 longitudinal girders corresponding to the 19 sections of the outer shell. Ten of these girders support the rollers, the nine placed between the others support the jacks. Each beam has different dimensions: the smallest is 315 mm. (12.40 in.) high, and the largest 495 mm. (19.49 in.).

The whole system is assembled with 20 mm. (0.787 in.) bolts, which allows the apparatus to be taken down after it has been used. The total weight of the shell and its framework is 30,700 kg. (67,540 lbs.). The forward end is armed with 8 cutting edges of cast steel, each being 150 mm. (5.96 ins.) long and 80 mm. (3.15 ins.) thick, and ending in front with a half round and a taper, and behind with a sleeve 60 mm. (=2.36 in.) long and 28 mm. (1.1 in.) thick, which allows the cutting edge to be fastened to the shell by means of 20 mm. (0.787 in.) bolts. These cutting edges vary in weight from 76 kg. to 150 kg. (167 to 330 lbs.).

CENTERS.—The centers are made of a metallic beam whose outside shape is parallel to and 65 mm. (2.36 in.) inside of the intrados of the Metropolitan arch. They are divided in two equal parts fastened together by means of bolts. Each of these parts is formed of a web 380 mm. (14.96 in.) high and 8 mm. (0.31 in.) thick, stiffened by curved angle irons $\frac{80\times80}{10}$ (3.15×3.15×0.39 in.) riveted to the web. The wall plate of each center is a flat iron 200×10 (7.87×0.39 in.) fastened on by two angles $\frac{80\times80}{10}$ (3.15×3.15×0.39 in.) with rivets countersunk underneath.

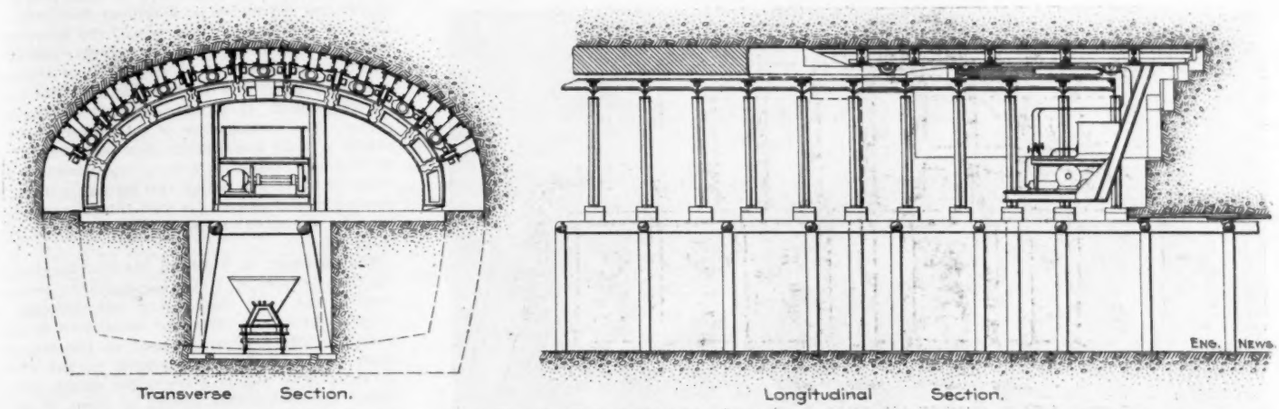
The center extends to 0.45 m. (=17.72 in.) below the springing lines of the arch. The web has bored through it, as certain points bolt holes to allow the attachment of 10 beams assembled to the center by 20 mm. (=0.79 in.) bolts; the thickness of the angles is taken up in the connection by a filler placed in either side of the web and made of 250×10 (=9.85×0.39 in.) plates.

On top of and for the whole length of the center there is a projection of 65×40 mm. (=2.56×1.57 in.) in the axis of each line of longitudinal beams, which forms the prolongation of the rails which surmounts the beam. To the inside curve of the center and underneath of two rails are fastened 4 angles which form cleats into which are set two wooden carriers which prevent the deformation of the center when the weight of the shield comes upon it. Finally, there is riveted to the top of each half center a piece of plate iron, in front on the right half, behind on the left, the plates acting as a joint covers when the two parts of the center are set up.

Each center weighs 900 kg. (1,980 lbs.). The normal number of centers under the shield and under the finished masonry is 30. The cast steel beams are 972 mm. (38.27 in.), which places the centers 1 meter apart c to c. They have at each end a shoe with 18 bolt holes and six cuts so arranged that the bolting of one to a center does not prevent the other from being fastened on. The top of each beam carries a rail 65 mm. (2.56 in.) high on the outside curve of the centers, corresponding to the projections noted already on these latter. This height corresponds to the thickness of the lagging which will be used later for the masonry. At one end and on both sides of the web of the beam is a notch of 170×100 mm. (6.70×3.94 in.) intended for attaching the thrust block of the jack. Each beam weighs 100 kg. (220 lbs.).

As the result of the strain caused by the weight of the shield coming on the center, the feet of the latter spread and there was a tendency toward a deformation of the center. In order to obviate this trouble the contractor now places the centers on a tie which keeps the feet at a constant distance apart. This tie is made of two steel plates 0.92 m. (36.22 in.) long and 0.20 m. (17.87 in.) wide by 0.009 in. (0.354 in.) thick. Each plate has an angle which forms a thrust block for the foot of the center. The two plates are connected by a bar 0.14 m. (5.51 in.) long by 0.009 m. (0.354 in.) thick bolted to them.

This bar is drawn to the rear of the shield in order to let the service tracks be laid; the plates are withdrawn at the same time as the centers. The center, its tie and the two carriers which support it rest on two cross sills which are laid, in their turn, on a floor which is made stiffer as there is less resistance in the subsoil. Besides this, the end of the sill placed under the carrier bears on a post driven into undisturbed ground in the lower gallery.



Transverse Section. Longitudinal Section.

FIG. 1. GENERAL DETAILS OF ROOF SHIELD FOR METROPOLITAN RAILWAY TUNNEL, PARIS, FRANCE.

ROLLERS.—Two rollers are fastened to the metallic frame of the shield. They are set in ten rows of which the six in the middle have six rollers each and the two rows on each side have only five each, on account of the back set of the rear end. Each row corresponds, naturally, to a line of rails on the centers. In order to give more slope to the earth to be removed, the seventh roller, which was placed at 1.74 m. from the cutting edge, has been left out. The overhanging in front is now 2.25 m., and behind it is 1.60 m. The rollers are of cast-iron, 0.25 m. in diameter, 0.10 m. tread for rails of 0.04 m. width on top, thus leaving a play of 0.06 m. for guiding the shield. In order to prevent their running off the track, each roller has two flanges 0.02 m. thick and projecting 0.02 m. (0.79 in.), making the total breadth of the roller 0.14 m. (5.51 in.).

Each roller is mounted on a soft steel axle 95 mm. (=3.74 in.) in diameter inside of the roller and 80 mm. (3.15 in.) in the boxes. The length of the axle is 0.415 m. (=16.34 in.). The supports are of cast-iron 30 mm. (=1.18 in.) thick and fastened to the frame by means of 20 mm. (0.79 in.) bolts. Each roller and its box weigh 70 kg. (=154 lbs.).

HYDRAULIC JACKS.—The barrel of the jack is composed of a cast steel tube 1.31 m. (4.30 ft.) long, 0.17 m. (6.69 in.) inside and 2.24 m. (9.45 in.) outside diameter, hence the thickness of the wall is 35 mm. (1.38 in.). This tube has two ears 1.00 m. (3.28 ft.) long and 95 mm. (3.74 in.) wide which are applied to the frame of the shield where they fasten on the jack by means of 22 bolts 20 mm. in diameter. The forward part is closed and only lets the water-supply pipes pass. The after part is free and bears against a cast iron assembling plate which acts as a guide and attaches it to the body of the jack. This latter is of cast steel, 1.30 m long, its inside and outside diameters being the same as those of the barrel. The body of the jack is closed at an end opposite the barrel by means of a cast-iron cover which lets the piston rod pass; water can be let in at the side. The diameter of the piston is 150 mm. (5.91 in.) and that of the rod is 120 mm. (4.72 in.). The

former slides in leather packing placed at the junction of the barrel with the body of the jack, and the rod in leather packing set near the cover. The total length of the jack is 2.685 m. (8.807 ft.) The piston is 2.865 m. (9.400 ft.) long and has a stroke of 1.13 m. (3.707 ft.).

The free end of the piston is fastened to an anchor-shaped mass of cast steel which serves for a thrust block. This thrust block, which is as long as the distance between centers, has at the forward end two arms which end in projections that lodge in notches cut for the purpose in the beams. At the rear end of this block are two arms which insure its direction by sliding on the beams.

The number of jacks was fixed originally at nine; as two were refused by the contractor after trial, only seven are in place, while four are enough. The jacks weigh 1,200 kg. (=2,640 lbs.) apiece; they were tested up to 350 kg. per square centimeter (4.978 lbs. per sq. in.).

HYDRAULIC PUMP.—The hydraulic pressure is furnished to the jacks by a pump with three pistons 25 mm. (1 in.) in diameter which is supplied from a tank of 700 liters (185 gallons) and driven by a dynamo which gives 25 amperes at 220 volts. The speed of the pistons is 40 strokes a minute. The suction valve is at the bottom of each pump cylinder and the discharge valve is at the top. The three discharge pipes of 10 mm. inside and 18 mm. outside diameter (0.39 and 0.71 in.) come together in one of the same diameter. A pressure gage graduated up to 500 atmospheres is attached to this pipe. The discharge pipe connects with the distributing leads; these leads in two series allow a double action in the jacks.

The nine stop-cocks on the side next the tank are used to move the shield forward, the other nine are used to bring back the pistons when the latter have reached the end of their stroke. Independent of the 18 stop-cocks just mentioned there are four others set in front of and behind each row and intended, those on the right to bring the water from the tank, and those on the left to return it thereto, so that if the shield is to be moved forward, the first stop-cock on the right of the front row and the last one to the left of the rear row are opened, and the water under pressure thus entering the forward system of stop-cocks is distributed to the jacks which must be brought into action. The water in the rear pump bodies is forced back into the rear system of stop-cocks which is left open so that the water can return to the tank.

A safety valve opening at 350 atmospheres is attached to the discharge pipe. The pressure per jack at 300 atmospheres reaches 53,000 kg. The whole of the machinery is set on a suspended metallic floor which is carried by four rollers running on two rails fastened to the supports of the centers. The machinery is drawn by the shield by means of a U-iron attached to the outer shell. The engine weighs 50 tons inclusive of all the parts which move with it.

MANAGEMENT OF THE SHIELD.—The earthwork is carried on at the front of the shield by maintaining a slope which varies with the consistency of the soil; the excavated material is thrown into a lower gallery excavated in advance. Before the shield is moved a center is placed in front and connected with the one last put up by means of girders which act as rails. As the weight of the shield has not yet come on this center it is easy to place the latter in the theoretical direction and in the position best suited for levelling. The center is placed however higher than necessary. Since the addition of the tie which prevents the spreading of the feet, only 1 or 2 centimeters of settlement are anticipated instead of 5 or 6 which were necessary before. The center is placed on the tie which, in its turn, rests on two cross pieces supported, on the right and left of the shield by a sort of floor which distributes the weight over a surface of 0.600 square meters (=6.46 sq. ft.) for each foot, and by a post which reaches down into the lower gallery. At this moment the line of the front rollers is immediately over the last center but one set up, the movement can now take place over a length of one meter which is the distance between one center and the next.

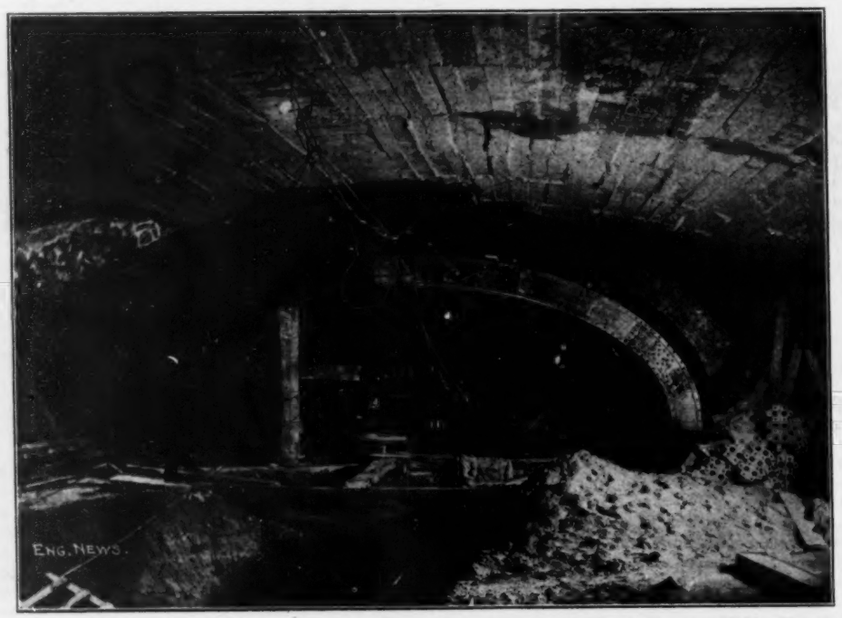


FIG. 2. VIEW OF METROPOLITAN RAILWAY TUNNEL SHOWING ROOF SHIELD IN PLACE.

The pressure is applied to the jacks whose pistons bearing against the thrust blocks cause the pump bodies to advance and with them the shield to which they are fastened. The thrust blocks which are secured to the longitudinal beams bear against these latter and consequently against the entire system of the 30 centers which, under normal conditions, are beneath and behind the shield. The possible stroke of each piston is 1.13 m.; the extra 0.13 m. being more than enough to correct irregularities which may be caused, especially in describing a curve.

The movement of the shield is given with the number of jacks deemed necessary by the machinist, taking into account sundry considerations of which the following are the more important: difference in friction caused by the soil; tendency which the shield may have to turn as the result of meeting obstacles which have not been loosened sufficiently in front; irregularity of pressure of the soil on the various points of the shield, etc. The pistons, when they have run out their full length, are brought back by making the hydraulic pressure act on the rear rod by a proper handling of the stop-cocks. As the piston is run in it brings with it the thrust block to which it is attached, and the curved bevel shape of the anchor allows the latter to leave the hole in which it was bedded, so that the whole system slides on the girders until the anchors fall, one meter further on, into the recesses of the following girders. The pistons are then home, and, at the next forward movement the heels of the thrust will bear against the ears of the next girder.

During the advance of the apparatus the cutting edges are freed so as to leave to these latter only the regulating of the excavation. The ground behind is laid bare by the advance of the tail of the shield. To prevent the earth from falling, sheets of steel ½ mm. (0.019 in.) thick are unrolled as the shield moves ahead and kept against the ground by means of scantlings which bear on the centers and the girders.

CONSTRUCTION OF THE MASONRY.—The tail of the shield is, as has been said, shaped out in such a way that it forms two steps, each 1 meter long. As the masonry is built behind the shield and not under it, it follows that, when the forward movement takes place, the masonry of the arch is built up on the first center behind the shield to one-third of its development above the springing lines, and to two-thirds at the second center behind. It is only finished at the third center. The consequence of the movement of the shield is that five masons can be at work; two on the new center which is uncovered for one-third of its length above the springing lines; two on the second center for two-thirds; one for fitting in the top and the key of the arch on the third center.

The masonry is built on wooden lagging laid on the centers; it comes against the sheets of steel of the roof, these being left, although the planks which hold them are withdrawn so far as possible. The masons engaged on the top, work from flying scaffolds suspended to the girders. As there is no masonry above the shield, but only under the immovable sheets of steel, it cannot possibly be disturbed; therefore it has not been noticed that any crack has occurred.

In order to give work to the masons who are unoccupied before the advance takes place, the low walls, in the part under the shield near the springing lines where there is no shell, can be built. This uncovered part is 1.20 m. (3.86 ft.) high. The masons are supplied from the back of the shield, the materials are brought in by the lower gallery and raised to the upper part by means of an inclined plane and an electric windlass.

In order to take down the rear center, a jack carried on a truck is placed under each half; the connection between the two halves is then unbolted and each of these halves, held up by the jacks, can be carried on the truck to the place where it is next to be used. A few working difficulties have led the contractor to prefer carriage by man power to carriage by truck.

The crew for the shield is composed of: 1 foreman and 1 machinist; 4 carpenters and 1 assistant for taking down and putting up the centers; 4 miners for adjusting the earthwork and for a part of the adjustment of the steel sheets behind; 8 laborers of whom 6 are at work with shovels and 2 attend to making up the trains in the lower gallery; 5 masons and 5 helpers. The mechanics, laborers and assistants engaged in removing the excavated earth, the making of mortar and bringing up materials, are not included in the above list.

THE COAL BRIQUETTING PLANT of the Western Fuel Co., at Oakland, Cal., takes its coal supply from ships by means of electric hoists, and from the receiving bins it is distributed to the 6,500-ton storage bins by cars hauled by third-rail electric locomotives. The coal for briquetting is crushed, screened and heated, and then mixed with the binding material (which has a petroleum base), after which it is fed to a Schorr briquetting press with a capacity of 370 briquettes per minute. The briquettes are 2¼ × 2¼ × 1⅛ ins., weighing about 9 ozs. and having a specific gravity of over 1.22. Belt conveyors deliver the product to the sacking department or to the bins. The plant is operated by electricity, and was designed by Mr. Robert Schorr.

AN EMERGENCY TRACK BRAKE FOR STREET RAILWAYS.

By F. F. Bodler.*

The emergency track brake here described is used on practically all the street cars in San Francisco. While San Francisco is an ideal city for operating street railways in many respects, especially as regards the absence of snow, ice, and sleet, yet it has its drawbacks, namely an enormous number of steep grades. In order to operate safely over these in wet weather and on slippery rails it was necessary to provide other means of braking a car than the wheel brakes. This is successfully accomplished by means of the track brake.

The first experiment with track brakes was made in 1893 or thereabouts, when the Market St. Railway Co. built a cable line on Market St. The brake was similar in principle to the present brake. It was placed on the rear truck and operated by a hand lever placed alongside of the grip lever. In 1893 the Market St. Railway Co. has an independent brake, operated from the end nearest the truck, and the rocker-arm has to be placed in the middle of the shaft, on account of the swing of the truck.

Fig. 2 shows a standard track brake shoe. This shoe is made of Oregon pine, costs about $.0275 and lasts about one week. The material to be used for shoes was the subject of many experiments. All kinds of wood, all kinds of metal, combinations of wood and metal, and metal with all kinds of inserts were experimented with. For cheapness, general utility, and highest braking efficiency the Oregon pine shoe was found to be the best. The shell for holding the shoe is made in two parts, of pressed steel. Two bolts pass through the holes shown in the shell and through the recesses shown in the shoe, not only clamping the shoe by means of the shell, but also preventing the shoe from slipping backward or forward. In order to facilitate the removal of worn out shoes, section of rail slightly longer than the shoe are sawed off and hinged

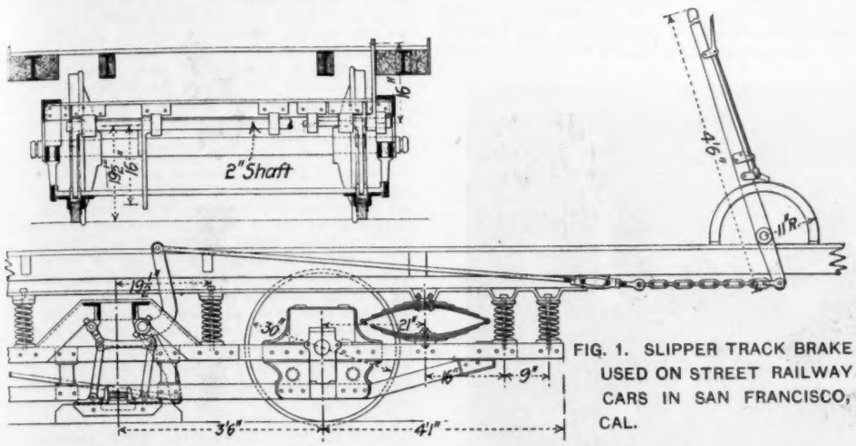


FIG. 1. SLIPPER TRACK BRAKE USED ON STREET RAILWAY CARS IN SAN FRANCISCO, CAL.

consolidated with several other lines and in 1894 commenced to change the motive power of some of its lines from horse and cable to electric. The first cars were of the single truck type, and were equipped with wheel brakes only. It was immediately discovered that an emergency brake was needed, as the cars could not be controlled on the grades, although the tracks were well sanded, and the wheel brakes were powerful enough to lock the wheels. This condition had not been met with on cable cars, as the cars could not go faster than the cable. In 1895 G. W. Douglas, then master mechanic of the Market St. Railway Co., started to experiment with a track brake on electric cars. Twelve single truck cars were equipped with track brakes, and operated successfully until 1899. In that year Mr. Douglas reconstructed his brake, and made it applicable to double as well as to single trucks. This is the brake which is now so successfully used in San Francisco. It is illustrated in the drawing herewith, Fig. 1.

The brake consists of a hand lever connected by a brake rod to an arm keyed on a rocker shaft extending clear across the truck. This shaft is connected on each end by means of a short lever keyed to the shaft, to a connecting link and to a toggle lever. The connecting link is connected to a second toggle system parallel to the first one. The shell for holding the brake-shoe is connected to the lower ends of the two toggles by means of pin lugs on the back of the shoe. By pulling back the hand-lever, the toggle levers tend to assume a vertical position and to force the shoe to the rail. Two guide-lugs on the shoe, one on each side of a channel iron across the truck, guide the shoe in a vertical direction. A lever with a counterweight attached to it, keyed to the main rock-shaft, acts as a release.

In order to adapt this brake to a Peckham or Brill single truck it is necessary to fasten a flat iron, bent as shown in Fig. 1, to the side frames, using the holes on each side of one of the spiral body springs. Two angle irons are placed transversely across the truck, and fastened to the bent flat iron. To these angle irons the brass boxes for holding the rock shafts are bolted.

To operate the track brake from the opposite end of the car, a second arm is keyed to the main rock-shaft, directly opposite the first arm, the brake rod being placed under and on one side of the motor.

Considerable ingenuity had to be exercised in order to place these brakes on all cars. The upper rocker-arm, for instance, in many cases had to be placed under the seat, the floor having been cut out. With a single truck car, the relative position of the arm on its rock-shaft does not make any difference. On double trucks each truck on the car house tracks. The cars are placed with the shoes over these hinged rail sections, the hinged rail is swung out, and by loosening the two bolts the shoes drop out. The time required for replacing four shoes on a double-truck car is about two minutes. The shoes can be adjusted when partly worn, by inserting wooden shims between the top of shoe and shell.

This brake can be applied only on trucks having outside hung wheel brakes. On double trucks it can only be used when the bolster spring is half elliptic, and hung under the side frames. It can not be used on M. C. B. bolsters, on account of lack of room. In fact it requires close figuring to adapt it in any case, to prevent the bolster from coming down on the connecting link.

It has been proved that the brake is most effective when hand-levers, as shown in Fig. 1, are used. The efficiency of the brake is proportionate to the rapidity and force with which the shoe is brought down on the rail. An ordinary ratchet handle with the ordinary spindle is of little use; with a cam on the spindle it is decidedly more efficient.

The strong points of this brake are: Extreme simplicity, high efficiency, low cost of maintenance, independence of all other brakes, and the fact that it is a purely mechanical contrivance.

This brake can readily be operated by compressed air, by the addition of a brake cylinder. To the writer's knowledge it has not been operated by that means, however.

Whether it would be as successful in cities where there is much snow, ice and sleet, as it is in San Francisco, the writer would not care to say, yet there does not seem to be any reason why it should not.

It may appear to some that on account of taking considerable weight off the wheels, there would be danger of skidding the wheels, yet the number of flat wheels has steadily decreased since these brakes were put on. The reason for this is probably that there is no need of "cinching" the wheel brakes up so tight as there was formerly.

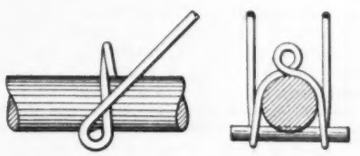
Cars are operated over one 17.5% grade, four 14.5% grades, and any number of 10 to 12% grades. A single truck car weighing 10 tons can be stopped on the steepest grade over which electric cars are operated in the city, in a reasonable distance, by first applying the wheel brakes, and then the track brake.

The original intention was to use this brake only as an emergency brake; it has been found so serviceable, however, that it is used almost as much as the wheel brake is. It ought not to be used on curves, switches, or crossings, but should it be used, about the only damage resulting would be a split shoe.

*Master Mechanic, United Railroads of San Francisco, San Francisco, Cal.

A FASTENING FOR SHEAR AND TENSION BARS IN CONCRETE BEAM REINFORCEMENT.

The accompanying engraving shows a method of securing an inclined shear bar or stirrup to a horizontal bar in reinforced concrete construction. The device consists of a steel key, shaped in section very much like a melon seed. A nick is made with a cold chisel in the under side of the reinforcing bar at the point where it is desired to locate the stirrup, thus forming the key seat. The wire stirrups are bent to shape over molds, and are then dropped into place over the reinforcing bar and the key inserted. Finally an extra half



Fastening for Shear and Tension Bars in Concrete Beam Reinforcement.

turn is put into the loop above the bar, thus drawing the key firmly into its seat and locking the stirrup in place.

This form of stirrup is considered to have several advantages over the style of vertical reinforcement now in use. Stirrups of any length desired can be placed on a bar with spacing as close as may be necessary, while at the same time they cross the potential shear cracks at right angles, and are rigidly attached to the horizontal bar. The shearing stresses are transmitted directly from the stirrups to the tension bar without locally straining the concrete at the point of connection. Bars of high carbon or structural steel, plain or deformed, may be used as the engineer desires. Keys sufficient to erect any ordinary job can be carried in stock at a small expense, and after the job is secured, used with whatever bar promises the quickest delivery. A plain bar fitted with these stirrups has a bond in the concrete similar to the deformed bar without them, and costs less besides reinforcing vertically.

A patent covering this key has been awarded to C. W. Noble, 15 North Monroe St., Kansas City, Mo., and arrangements are now being made for putting the article on the market.

SIZE AND NUMBER OF UNITS IN ELECTRIC GENERATING STATIONS.

In the course of a paper on "The Power Station," read by Mr. F. N. Bushnell* before the American Railway Mechanical and Electrical Association last week, a striking illustration is given of the important influence which the choice of size and number of generating units may have upon the coal consumption of an electric power station. It has long been realized that proper selection in this matter is important, but the magnitude of the relative effects produced by good and bad selection is not clearly appreciated.

The main factor in the question is, of course, the fact that prime movers operate less efficiently (usually much less) at light loads than at full loads. That is to say, it is cheaper to run one engine fully loaded and have the other lie idle than to run both engines at half load. But Mr. Bushnell points out another factor which has an effect in the same direction. In electric railway power stations it is not regarded as practicable to change the speed of the air or circulating pumps, or to alter the quantity of cooling water to suit the varying loads upon the station, and these auxiliaries are usually operated at a point sufficient to take care of the maximum load. Their steam consumption per engine is therefore practically constant, and their steam consumption per unit of output will vary about inversely as the ratio of full-load on the corresponding engine. Under ordinary operating conditions, where the exhaust steam is used for heating the feed water, only about 12% of the heat in the total steam generated can be used for this purpose, and all steam used by the auxiliaries in excess of this must go to waste; and it follows that the percentage of loss in the auxili-

*Chief Engineer, The Rhode Island Co., Providence, R. I.

aries will increase very rapidly as the load upon the main engine decreases.

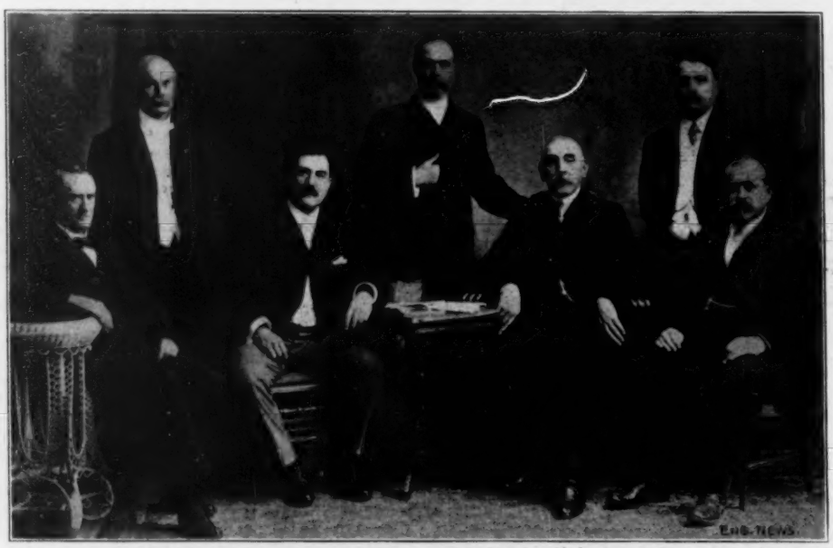
The two factors mentioned result in a distinct economy from such a number and proportion of generating units that, at all times of the day, the units in operation may be run at nearly full rated load. The following case, taken by the author from the operating statistics of two stations, illustrates the importance of the subject. These stations, A and B, furnish power for suburban railways upon which sufficient cars are run to provide a fairly uniform load during the greater part of the day, although subject to more or less violent temporary fluctuations. The general designs of these stations and their equipments are such that the fuel used per kilowatt-hour should be practically the same, provided the engines could be kept well loaded in both cases.

In Station A there are three units, and the load conditions are such that one unit is operated during the night and early morning, when the travel is light; two are operated during the greater part of the day, and three at the peak of the load, which occurs shortly after six o'clock in the evening. By careful attention to the changes in the load, it is always possible to keep the running engines fairly well loaded. In the case of Station B there are two units. The load at night and early morning is very light, so that the engine used is only about half loaded for this period, whereas for the greater part of the day the load is a little more than one engine should be required to carry, and it is therefore necessary to run both engines. The result, of course, is that the average load on the station is only a little more than 50% of the rated capacity of the running engines, and they are consequently extremely wasteful of steam; and, too, the exhaust from the auxiliaries is probably quite a little in excess of that required to heat the feed water, which will also account, in a measure, for the low efficiency of the plant. The record of this plant is 5 lbs. of coal per KW.-hr., as compared with 3.8 lbs. for Station A. The greater part of the discrepancy is undoubtedly due to the more efficient load conditions in the latter station. It is probable that had a storage battery been added to the equipment of Station B, the load on the engines could have been regulated so as to have made a much better showing in coal consumption; Mr. Bushnell believes, however, that the use of three smaller engines in place of two large ones would have been the proper solution of the question. Undoubtedly a saving in coal of from 15 to 20% would have resulted from the use of engines better proportioned to the load.

Inferences from this illustration must be made with care, it will be evident, as the character of the day's load-curve will be in general different for different cases. But the considerable influence of proper choice of units is satisfactorily demonstrated, and in the case of small or middle-sized stations it is shown that the designing engineer's choice of units will determine the economy of the plant to far larger extent than his specification of dynamo efficiency.

THE INTERNATIONAL WATERWAYS COMMISSION.

As many of our readers will recall, agitation has been active for at least a dozen years concerning the water level of the Great Lakes, and the effect upon that level of the navigation improvements made on the connecting channels and the abstraction of water from Lake Michigan by the Chicago drainage canal. These questions are necessarily international in their character, and as a final result of the long-continued agitation an International Commission is now engaged in their investigation. The accompanying group photograph shows the members of this Commission among which, it will be noted, are several well-known engineers. The names of those shown in the group, beginning at the left and going toward the right, are as follows:



THE INTERNATIONAL WATERWAYS COMMISSION.

George Clinton, Esq., of Buffalo, N. Y. Attorney.
Geo. Y. Wisner, M. Am. Soc. C. E., Detroit, Mich.
Jas. C. Mabee, K. C., Chairman Canadian Section, Toronto.
Jean Louis Napoleon Costé, M. Can. Soc. C. E., Port Colborne, Ont.
Col. O. H. Ernst, Corps of Engineers, U. S. A., Chairman American Section.
Thos. Cote, Secretary Canadian Section.
W. F. King, B. A. LL.D., Chief Astronomer of Canada, Ottawa, Ont.

THE MANUFACTURE OF WROUGHT IRON AND THE RELATIVE RESISTANCE TO CORROSION OF WROUGHT IRON AND STEEL.*

MR. C. EDWARD STAFFORD, Chester, Pa.:—During all my business life, I have been engaged in the manufacture of Bessemer and open-hearth steels, but, during my long connection with the Shoenberger Steel Co. of Pittsburg, I had some experience in the manufacture of high-grade puddled iron for horseshoes and in the making by Dr. Otto Wuth's process extremely pure low phosphorus puddled blooms (analyzing from 0.005 to 0.01% of phosphorus and sulphur), which were melted with low-phosphorus pig-iron in acid open-hearth furnaces to make extra locomotive fire-box steel. I have also seen the Dank's puddlers in operation at different times and places, notably where they were most successful, at the Otis Steel Works, Cleveland, Ohio; then under the management of our friend, Mr. S. T. Wellman. These Dank's blooms were made solely for open-hearth melting-stock, to which they were well adapted; the unavoidable presence of bits of ore-fix imbedded in the mass of the metal always prevents the profitable manufacture of merchant iron from Dank's blooms.

With the experience just described, I was to some degree in position to value fairly the means, methods and results of Mr. Roe's mechanical puddling from the metallurgical or technical and economic points of view. I was given an opportunity by Mr. Roe to see his puddling furnace or machine in operation in Pottstown, Pa.

Briefly, the furnace, with water-cooled bottom, is rectangular in plan, about 20 × 8 ft. in the clear, supported by trunnions at the middle of the long sides, at a height of 17 or 18 ft. above the general level; the oscillation (65° each way from the vertical) is accomplished by geared segments (attached to the downward-projecting side or trunnion-plates) with which engage pinions driven by a reversing engine. The whole section of the discharge-end of the furnace is closed by a water-cooled hinged door; in the side at this end is an opening for scale or ground-ore additions; at the receiving or working end there is a slag tap-hole and on the side a detached spout into which are poured the liquid iron and oxides. The bottom and the sides to a height somewhat above the slag-line are lined with magnesite brick; above the slag-line and for the roof, firebrick are used. Coal oil and blast are introduced through the two trunnions and the products of combustion escape through two segmental stacks at each end of the furnace, discharging into the atmosphere at a distance of about 16 ft. measured from the trunnion on a line at right angles to the bottom of the furnace.

The cycle of operation is, briefly, as follows: Molten cinder is run into the furnace to seal the discharge door (which has been opened to discharge the preceding heat and immediately closed) and to lubricate the bottom. The oxidized metalloids of the metal enter into and combine with this cinder. Molten iron direct from a blast-furnace is then poured in, followed immediately by roll-scale or easily reducible iron ore charged through the side opening near the discharge end. The furnace is then oscillated, and scale or ore additions are made between oscillations until sufficient has been added; the quantity varies with the percentage of metalloids in the metal. When the bath is nearly desiliconized the greater part of the cinder is "bled" off, and additional molten cinder is added in order to lubricate the bottom and form the welding cinder; next, roll-scale or iron-ore is added to decarburize the iron. Between the various additions, the machine is oscillated to agitate and keep the iron and cinders thoroughly and uniformly mixed. When the iron "comes to nature" it is compacted into a comparatively slag-free mass by sliding down the hearth of the machine against the ends. The discharge door is opened, the furnace is quickly turned down; then the mass slides out by its own weight into an hydraulic squeezer of special design, and is compressed therein in the three dimensions into a squeezed slab ready for direct rolling in the blooming mill.

Immediately following the discharge of the mass from the puddling machine or furnace the end door is closed and a new cycle at once begins as no "fixing" is necessary.

The apparatus is efficient, well adapted to the purpose, apparently durable and comparatively little subject to wear and deterioration.*

The process is always under even more immediate control than the open-hearth process of making steel. The reactions of the process are well-defined and more open to the observation of the operator, who can hasten or retard them by manipulation of the flame and furnace, and by the time, character and quantity of the additions. The iron is more thoroughly worked or wrought than is possible by manual labor in the ordinary puddling furnace.

The finished iron is more regular in its constitution than iron made by ordinary means and methods, and as free from slag. It is possible to produce regularly at will iron of a tensile strength of from 48,000 to 60,000 lbs. per sq. in. The superior character of the iron is indicated by the following mechanical tests 8 ins. in length.

	Net Strength per sq. inch. Pounds.	Elongation. Per cent.	Reduction of Area. Per cent.
Plate Iron.			
7-in. by ¼-in.....	50,319	27.5	39.4
7-in. by ½-in.....	52,720	28.7	48.6
Merchant Iron.			
⅝-in. round.....	54,980	32.25	.....
¼-in. round.....	54,230	33.00	.....

On comparing the means and methods used in ordinary hand puddling with those employed in the Roe process, the great economies of the latter will be readily understood.

The ordinary unit of production is the puddled ball of about 180 lbs., whereas the Roe squeezed slab is 4,000 lbs. and readily may be twice that weight or the same weight as Bessemer and open hearth steel ingots.

In ordinary puddling, the loss is from 4 to 6%, and in the Bessemer and open-hearth process it varies from 5 to 9%. In the Roe process there is a gain of about 4% derived from the additions of ore scale and cinder.

The Roe process is capable of using pig-iron having a wide range of composition. It has successfully used irons

*Discussion at the Washington Meeting of the American Institute of Mining Engineers of a paper by Jos. P. Roe, Pottstown, Pa., on the Production and Characteristics of Wrought Iron.

*See illustrated description of the Roe furnaces in Engineering News of May 7, 1903.

varying in silicon from 0.2 to 3.5%; sulphur from trace to 0.6%; and phosphorus, 0.3 to 2.5%. These differences in composition are taken care of by varying the additions of mill and cinder and by manipulation of the furnace. The object of making the heat does not seem to be much affected. A 2.5-ton Roe puddling furnace with three attendants producing 30 tons of squeezed slabs per turn of 8 hours does it at an immense saving in labor and fuel over ordinary method of hand puddling.

The is well known by the ordinary puddling process, 'muck bar' is rolled from the "ball;" and when cold it is cut into specified lengths for piles for the finishing mill. By the Roe process the place of the loosely constructed heterogeneous and expensive "piles" is taken by clean, solid and cheaper billets.

The re-heating of the solid iron billets from the Roe process does not result in as much waste as where muck-bar piles are re-heated. A fair-sized pile will lose about 10 or 11% in an ordinary heating furnace, while these solid iron blooms will lose only 5 or 6%, and the reheating of the solid blooms does not take as much time or fuel; important economies in manufacture.

In reckoning the comparative blooming mill costs of soft steel and of Roe iron billets, it must be remembered that the croppage of the iron billets would be much less than in rolling steel, as the ends of the finished iron billets or slabs would have to be merely cropped off square, while with steel heavier croppage is imperative to obtain billets solid at the ends and to get rid of the segregated portion of the ingot. After blooming, the iron billets or slabs may be treated precisely the same as steel; that is, they may be rolled direct, or allowed to cool and later be reheated for further rolling.

The low cost of Roe puddled iron, as in steel making, is largely due to intelligent dealing with large masses and tonnages by machinery; thereby displacing expensive manual labor, working slowly, irregularly and wastefully, with small units and quantities. The greatly increased production and low cost is not gained at the expense of quality. The quality is generally better.

The Roe process is a technical success, and from the brief observation I have given it I do not see why Roe iron billets or slabs should not be made as cheaply as soft Bessemer steel billets in the same district and making the same daily tonnages. This low cost of producing a most excellent quality of iron opens up a wide field for iron from which it cannot be driven by the competition of Bessemer and open-hearth soft steels. We know that, for many purposes, iron is preferred to steel when it can be had at the same price, and, in some important cases, where even higher prices must be paid.

The Roe mechanical puddling process is a distinct advance in the metallurgy of iron. I am confident it will stand as an important commercial process alongside the Bessemer and open-hearth steel processes.

DR. CHARLES B. DUDLEY, Altoona, Pa.:—Those of us who are using metals continuously cannot help noticing at the present time a distinct trend toward a return to the use of wrought iron in place of steel in certain constructions. It is well known that, for the last 20 or 25 years, the trend has been markedly in the other direction. Wherever possible, steel has been substituted for iron, and it may be said with all honesty, that the belief and feeling of those who have guided this matter have been that the substitution of a homogeneous, well-made metal like steel, for a non-homogeneous metal like wrought iron, which was apt to be full of flaws and bad welds, was not only wise, but clearly a step in the right direction. However, as we have obtained more experience with the use of steel (and I may say that it has apparently taken about 20 years to get this experience), we are finding that, in certain constructions, steel is not proving to be as satisfactory as we had hoped. This may be due partly to lack of knowledge, which has led us to use steel of a grade not fitted to the work, and it may be partly due to the design, since, when we change from one metal to another, it does not necessarily follow that the same construction and size of parts will give satisfactory results; and it may be partly due to workmanship, since it does not necessarily follow that the two metals can be treated exactly alike. Whatever the cause, the difference in the behavior of the two metals in service, at least, in certain constructions, is very clear. We are inclined to think there is a fourth cause, perhaps more important than any of those already mentioned, namely, the nature of the two metals.

In order to make clear what we have in mind, it will be essential to say that the place where iron and steel behave so differently, and apparently to the advantage of the iron, is where the metal in service is subjected to bending-stresses. We have very little evidence that where the metal is used in simple tension or compression, steel is not by far the better metal, but when we come to bending-stresses we are apparently in a different field. It is perhaps not too much to say that almost every part of a structure that moves and carries a load is subjected to bending stresses, sometimes in both directions, and sometimes in only one. A good example is a car axle. At each revolution, the axle almost throughout its whole length is subjected to bending stresses. Other examples are driving axles, crank pins, piston rods, where they fasten into the crosshead, equalizers and locomotive frames. This list might be extended almost indefinitely.

Considering bending stresses, it is evident that the outside fibers of a piece of metal subjected to bending stresss have a more severe strain than the inner ones, and it is of course evident that the conditions under which the bending stress is applied being known, it is possible to calculate the strain in the outside fibers. This is technically known as "maximum fiber-stress." If the bending is all in one direction, the maximum fiber stress may be in tension, or it may be in compression. If it is in both directions, the maximum fiber stress is alternately tension and compression, and, so far as known, equal in amount.

Coming now to actual conditions of service, in a car axle, for example, the maximum fiber stress allowable by calculation is from 18,000 to 20,000 lbs. per sq. in. in certain parts of the axle, and from 7,000 to 10,000 or 12,000 lbs. in other parts. The experience of the Pennsylvania railroad indicates that, with this maximum calculated fiber stress, if the metal used in car axles is steel of not above 65,000 or 70,000 lbs. tensile strength, the axle will sooner or later fail in service. The method of failure is peculiar and worth a word of remark. For example, instead of the journal breaking off from the axle suddenly, due to shock (as we are quite accustomed to see things break), apparently the metal that has the maximum fiber stress begins to break without any elongation or stretch. This, of course, will be at the surface of the journal, usually at the fillet of the shoulder. A single fiber, if we may use the expression, having broken, the next fiber underneath it receives the maximum fiber stress slightly increased, and it ultimately fails, and so on until, after a while, there will be quite a large portion of the section of the axle broken off in this manner. Then some sudden shock breaks the rest of it and the journal drops off. This breaking of the parts subjected to the maximum fiber stress, a little at a time, is known as "detail fracture," or sometimes as "progressive fracture." It is a real difficulty and occurs in many places besides car axles.

With our present knowledge of the subject, the remedy for the failure of a part due to detail fracture is twofold: (1) either increase the size of the part, which with the same loads will diminish the fiber stress, as is clearly evident, or, (2) change the nature of the steel, so that the ratio between the calculated maximum fiber stress and the ultimate tensile strength will be greater; that is to say, if we may trust the experience of the Pennsylvania railroad, if the maximum fiber stress between wheels is 20,000 lbs. and a steel of 65,000 or 70,000 lbs. tensile strength is used, sooner or later there will be failures in the car axles between the wheels. On the other hand, with exactly the same sizes and loads, and consequently the same maximum fiber stress, if the steel used is from 80,000 to 85,000 lbs. tensile strength, there will be no failures during the life of the axle.

The point to which I am leading and to which all that I have said is preliminary, is this: Iron and steel do not behave alike, when subjected to bending stresses. We think it is perfectly safe to say that a well-made iron car axle, the metal of which will show in tensile strength from 48,000 to 52,000 lbs. per sq. in., will stand successfully the same fiber stress as steel of 80,000 to 85,000 lbs. tensile strength. Just why this is so, I am unable to explain, but there is a very large amount of accumulated experience which seems to indicate that a metal like iron, which is believed to be a bundle of fibers, each one surrounded by slag, and which has within itself the power of the distribution of the strain, is a more reliable metal when subjected to bending stresses than a perfectly homogeneous metal like steel. This is hardly the place or the time to go into a discussion of this phase of the case, and so I close by saying, that the present outlook seems to be that if wrought iron can be made in sufficiently large masses, so that flaws and defective welds will be eliminated, it might again become a successful rival of steel, especially if it can be made at a cost that will permit of commercial competition.

DR. ALLERTON S. CUSHMAN, Washington, D. C.:—My connection with this discussion is rather indirect, because I make no claim to have had very much experience in the problems that are presented to iron and steel men, whether manufacturers or users, but I occupy the position of chemist in the Division of Tests of the Department of Agriculture, and so many complaints have reached the Department as to the lasting quality of modern steel wire, which is sold to American farmers for fencing purposes, that the Secretary and the Assistant Secretary of Agriculture have interested themselves in the problem, and have asked me to investigate it, or at least to begin the collection of data with a view to making a thorough investigation of the whole subject.

I knew of no reason why modern steel wire should not last as long as the older wires. Inquiries among men who have had a large experience did not lead to any satisfactory source of information. Text-books on the metallurgy of iron and steel contain contradictory statements, and the question seems to be one as yet unanswered.

Several of the influential farmers' journals in the country have taken up the matter, and in every issue we are reminded that something ought to be done. Farmers complain that galvanized steel wire fences go to pieces in two or three years, and yet some of these farmers have fences on their farms which were put up 30 years ago. I am not ready to report upon what we have done so far in any direct way, because the work is very young.

After having examined carefully in the laboratory samples of iron and steel wire that had failed and of wire that had not failed, we noticed that those which had failed contained manganese as high as 0.4% in the large majority of cases, while wires which lasted did not contain manganese at all. If, however, the solution were as simple as that it would not have been a problem, and we realized that this point would have been observed long ago. As a matter of fact it is not so simple.

We thought that perhaps the best way to begin was to get as pure iron as possible by the Goldschmidt-Thermit process and commence with that, and then see if we could work out a laboratory method of studying the problem. The first thing we did was to make laboratory ingots with different percentages of manganese. By making ingots of definite composition we thought we might perhaps work out a laboratory method of determining the relative rate of oxidation.

As far as we have gone this much seems to be true: Iron which is free from manganese is not so readily oxidized by very dilute solutions of hydrogen peroxide as those irons which contain appreciable amounts of manganese. The very dilute solutions of hydrogen peroxide that we used are not unlike rain-water, that is to say—thunder-shower water. It is easy to make in the laboratory solutions of nitric acid, carbonic acid, etc., and thus approximate the conditions that wire is subjected to out of doors, i. e., rain-water containing small amounts of hydrogen peroxide, carbonic acid, nitric acid, sulphuric acid and other constituents.

A number of samples have been collected from farmers. Some were found in very good condition and others in extremely bad condition after 30 years of service. We believed that the good wires would prove to have no manganese in them and that the bad wires would run high. As a matter of fact it did not invariably turn out that way, but I think it is safe to say that in the majority of cases, and especially with the modern steel wires made by the Bessemer process, the presence of manganese does increase the rate of oxidation; that is, manganese has something to do with it directly. With the iron wires, so far as we have gone, it does not look as though the manganese had so much to do with the matter. It naturally occurs to one that the distribution of manganese in the metal may possibly be the cause of the trouble. If we have manganese very evenly distributed throughout the mass of the metal, electrolytic action need not necessarily be set up, but if there be unevenness in the distribution of the manganese, then electrolytic action leading to pitting and pock-marking of the iron may take place. All we can do is to speculate pending a systematic investigation of the matter, which it seems to me has not yet been made by any one.

The Department of Agriculture has determined to find out, if possible, why these fence wires go to pieces so rapidly, and hopes that manufacturers will cooperate in discovering the reasons for the trouble noted.

The wires were badly pitted or pock-marked. If the whole surface of the iron had rusted it would not have been so bad, but in nearly every case the old iron fence wire was badly pitted, and sometimes these pits extended nearly through and then the wire would break. You remember that in the old days they made wire heavier than now. The increased tensile strength of steel enabled them to use less metal for the same strength, and that has something to do with it. Then further, exposure to the action of the elements plays an important part. To-day they twist the strands of wire, thereby forming little cups where the water is lodged, allowing a rusting point. Making every allowance, there is no doubt that modern wire is not as lasting as it should be.

I am told by men who are using steel pipe, that, as compared with iron pipe, steel pipe pits, and there are many in this country who are discontinuing the use of steel pipes for this reason. My experience leads me to the same conclusion that Doctor Dudley has reached, that is to say that the time is coming when perhaps a return to the older processes is going to yield a metal better suited to certain purposes than the more convenient modern processes.

J. E. JOHNSON, JR.:—Did you ever make any comparison of the contents in sulphur and manganese? This may be important, because the manganese will be present as sulphide of manganese, as long as there is any sulphur to take up, and probably some will be in the form of sulphate.

DR. CUSHMAN:—I realize that the problem is complex, and that the inquiry suggested would be very interesting, and (like other collateral investigations not yet executed) must be made before a final solution can be reached. I do not think any one knows whether the action of the manganese is catalytic in its nature, or whether it is due to the mere fact that manganese oxidizes rapidly, or again, whether the action is electrolytic.

JOSEPH HARTSHORNE, Pottstown, Pa.:—It is, of course, well known that the chemical composition of iron

and steel has a great influence upon their resistance to corrosion. For instance, the presence of any nickel retards oxidation and a sufficient quantity will prevent it entirely. It seems very probable, therefore, that, as suggested by Dr. Raymond, manganese has a decided effect and that it is in favor of oxidation, but I do not remember any report of tests bearing directly on this point.

Other elements undoubtedly exercise considerable influence. In this connection a series of tests, made by Engineer Diesel, of the German torpedo service, are important. They cover the relative corrosion of certain alloys by sea-water.* Among these alloys was "flusseisen," or soft steel. The results on this material show that phosphorus has a protective effect against corrosion, since the plates with high phosphorus resisted corrosion better than those low in phosphorus. They also show that there is an electrolytic action between plates of different contents of phosphorus when in contact, whereby the low phosphorus plate corrodes much faster, than when isolated or in contact with plates containing like amounts of phosphorus.

The extreme probability that the presence of manganese increases the liability to corrosion, while that of phosphorus decreases it, affords a good reason why puddled iron should resist corrosion better than steel, since iron rarely contains more than a trace of the former element and usually contains very much more of the latter than is allowable in steel.

Like all laboratory experiments in this line, however, those just referred to, while very interesting and important, are merely indicative and not demonstrative. The samples used in such tests are not subjected to the ordinary conditions of practice and the results obtained may or may not correspond to those obtained in practice. For instance, the samples are merely suspended in the attacking medium, such as sea-water, dilute solutions of mixed acids, hydrogen peroxide, etc., in a quiescent state, while in practice the surface is generally subjected to movement and stresses of various kinds. From this it results that the rust is shaken off as it forms and fresh surfaces are continually being exposed. I do not mean to assert that this action always hastens corrosion, under some circumstances it might even retard it, but merely to point out the inherent differences between the two sets of conditions.

Such experiments can only show the relative rates of corrosion of the substances investigated under the conditions given. They may indicate, perhaps very definitely, the probable rate at which the substance will corrode in practice, but cannot determine it with, say, anything like the accuracy that an analysis for phosphorus will show the capacity to resist shock. The only way in which this question can ever be settled, it seems to me, is by the collation of as many examples from actual practice as possible, preferably those in which iron and steel are used side by side under the same conditions, either intentionally for comparison or incidentally.

As examples of what I mean I will refer to two incidents in my own experience, although many of you have probably met with the same. A Bessemer steel works was built under my supervision in 1885, the roof and sides of which were made of corrugated iron sheets of heavy gage. They received two coats of paint on both sides before erection and one on the outside when in place. The sheets were put on in the latter part of 1885, blowing began in July, 1886, and ceased finally in August, 1893. Since that time most of the buildings have been entirely neglected. Extensions were erected at various times, generally after 1889, for which steel sheets of the same gage were used and treated in the same way. The parts of the first roof immediately over the cupolas and converters were renewed twice during the eight years of running, but the rest of it was not touched, except to repaint it once on the outside. Much of the roof and a still larger proportion of the sides will still turn water after 20 years, although they have not been painted for 11 years and the wind has had free play with the sheets, which were never fastened if they got loose. None of the steel plates lasted over four years and a part which was reroofed with steel sheets in May, 1901, now requires renewal.

In 1885 a smoke-flue, made of galvanized sheet iron, was put in with the furnace of the house I then occupied and, when I left it in 1893, it was apparently in as good condition as when new. A flue, similar to the other in every respect except that it was made of sheet steel, was put into my new house in 1893, in connection with a furnace of the same size and make and under the same general conditions of firing, but in a drier cellar. This flue has been renewed twice in the 12 years since then, on account of having rusted out.

My experience with tinsmiths and roofers: There is a general complaint that the galvanized and tin sheets of the present do not last anything like as long as those made 25 or 30 years ago. The old men, who have had experience with both kinds, say that the present sheets last only a fourth or a fifth as long as the old ones. Only a few attribute this to the old sheets being made of iron and the present ones of steel, but, on the other hand, few of them know this fact or appreciate what it means.

I was very glad to hear Dr. Dudley, whose opportunities for investigation and observation are unsurpassed, indorse the remark I made this morning in announcing this discussion. My own investigations had led me to believe that iron was the better material for many of the purposes to which steel is now applied, and it seemed to me that the decided trend of opinion, not only among tradesmen, but also among engineers and investigators, was in the same direction. If this opinion be warranted by the facts, as now, more than ever, I think it is, then the use of iron must largely increase in the near future. Much more so must this be the case if, as stated by Mr. Stafford, puddled iron can be produced by the Roe process as cheaply as steel is now produced. My own knowledge of the Roe process leads me to agree with Mr. Stafford.

MR. N. B. WITTMAN, Philadelphia, Pa.:—Several years ago during the latter 80's and up to the early 90's, the substitution of both Bessemer and open-hearth soft steel, for purposes previously held by wrought iron, caused many capable observers to hold the view that wrought iron would soon fill but an unimportant part in metallurgy. In looking over the "Directory of the American Iron and Steel Association," the rapid decline in the number of active puddling furnaces reported up to the year 1898 will be noted. The entire withdrawal of such important firms as the Carnegie, Cambria Steel, Jones & Laughlins and others, from puddling was responsible for the greater part of the decline. Since 1898 this movement, on the whole, has been checked and a study of the "Directory" will show a very important increase in the number of active puddling furnaces in certain localities and among old-established firms, who have held to iron for certain purposes irrespective of locality. In eastern Pennsylvania to-day many new puddling furnaces are being built, and even in Pittsburg many of the firms which have held to the iron business are larger puddlers than in 1898.

The superior shop-working qualities of soft steel, together with attractive physical tests and analyses, naturally commend it, but the test of use unquestionably shows that, for many purposes, it is not so durable as iron. Several years ago the iron nail was practically driven out of the market by the cut-steel nail; after a time it was found that structures nailed with steel nails would not hold because the nails rusted off under the heads very rapidly; it was also found that for scaffolding and similar purposes steel-cut nails had less holding power than cut-iron nails, and a demand has again sprung up for the cut-iron nail; the tonnage of the latter at present produced is still small, but it is large compared with what it was several years ago and it is still growing.

For wrought-iron pipe, notwithstanding the higher cost of production, the demand has been sufficient to employ several important works exclusively for the manufacture of this product. For boiler tubes, steel has not been satisfactory, and although almost all new stationary boilers are equipped with steel tubes, principally because they cost about $1 per horse-power less and are preferred for easy working, the general experience has been that, with most waters, they are not so durable as the charcoal-iron tube and the greater part of locomotive tubes are made from charcoal-iron skelp. In this connection I know of an important steel manufacturer, and therefore without prejudice in favor of iron, who will not have a steel tube in the boilers nor a steel sheet on the roofs of the buildings.

Another important concern, well known as producers of steel for special purposes, has not been able to make steel suitable for stay bolts, and it is increasing its iron-puddling capacity at this time, principally for the purpose of making stay-bolt iron.

In view of Mr. Roe's admirable statement concerning the structure of iron, I believe that, if we could divest ourselves of prejudice and forget that we have ever regarded ourselves as iron men or as steel men and would use our metallurgical knowledge only in forming opinions, we would, in view of the stable nature of the silicate of protoxide of iron which envelops the grains of iron, and in view of the rougher surface, which results from it, conclude that, for holding protecting material and for resisting corrosive influences, iron is superior to steel; while for deep-stamping purposes, requiring equal strength in all directions and for purposes in which high tensile strength and elasticity are required, or for any purposes in which temper is essential, steel is obviously superior to iron. If this view is correct, the importance of Mr. Roe's puddling process is apparent; it embodies every element of successful puddling and is capable of the same scale of operation as either of the steel processes. The ordinary puddling process is the only metallurgical process in practical use to-day which can successfully and economically deal with sulphur. This advantage is retained in the Roe process, in addition to which the allowable silicon and phosphorus contents of the initial pig iron permits a wide variation, which makes available fuel, ore and limestone, which would be unsuitable, or at least not economical, for producing metal to be used by the Bessemer and open-hearth processes.

As Mr. Stafford has pointed out, the possibilities of economical production through heavy tonnage are the same as in the steel processes. In view of the probability that the future increase in tonnage of iron and steel will be largely along the lighter lines, there is a need for material in these lines which will better resist destruction than mild steel has done.

JAMES P. ROE, Pottstown, Pa.:—While steel has permanently displaced iron for many purposes, yet in many instances it has not proved satisfactory. Such instances are becoming more frequent, and many makers of finished material would welcome a change back to iron.

The investigation of the corrosion of iron and steel fencing wire that is being made by the Department of Agriculture will have far-reaching economic results. In iron the manganese exists as oxides in the slag, and therefore is not subject to further oxidation; in properly worked iron this slag is distributed with reasonable uniformity; that is, only such slag is present as envelops the original grains, being reduced somewhat in volume by subsequent work; in such a condition it offers its greatest resistance to corrosion. When an undue quantity of slag is present in pockets or laminations it is fragile, cracks off readily and possesses little protective value. Moreover, some samples for analysis might be taken by chance at points where pockets of slag exist, in which case the determinations would show a relatively high manganese content. On the other hand, the manganese in steel exists as metal held loosely as an alloy, a condition favorable to electrolytic action, especially if the manganese is unevenly distributed.

Mr. Hartshorne's remarks in regard to presence of phosphorus in iron increasing its resistance to corrosion is confirmed by my own experience in the relative corrosion of iron containing high and low phosphorus.

Mr. Whitman's reference to the increase in the number of active puddling furnaces in the United States is important, since it represents an increased demand for iron at a price materially higher than that of steel. The same condition exists in Germany, France and England, and I am advised that the supply of puddled iron abroad does not meet the demand.

A 75,000-GALLON CONCRETE STEEL CISTERN.

By Edward Godfrey.*

The accompanying drawings show a concrete-steel cistern which was built last winter for the Pittsburg Lamp, Brass & Glass Co., at Allegheny, Pa. The cistern is to be used for fire protection; the water is to be pumped into the sprinkler system in case of necessity.

As seen from the drawings, the location is in a court between two buildings. It was necessary to take care of the foundations of the walls of these buildings, and in order to do this the cistern was made with side vertical beams, which reach under the walls of the buildings and act as piers for the same. In the construction, excavation was first made for these piers and at the same time trenches were made across the cistern connecting the excavations for opposite piers. In this way only 18-in. portions of the building walls at intervals of 8 ft. were undermined. The excavation for the cistern proper was not made to the extent of impairing the building foundations until these piers were made and had been allowed to stand for two weeks.

After the trenches for the piers had been dug the rods in the same and the rods reaching across the cistern were placed. Then forms were set up to confine the concrete of the piers to the line of the outer surface of the cistern walls. The soil is a mixture of sand and clay, and, as the work was done in freezing weather, it froze sufficiently to make it unnecessary to use much in the way of outside forms in either the piers or the cistern walls. The soil would probably also have "stood alone" if it had been dry; but it did give some trouble by caving in when the weather moderated and the thawing made it wet and heavy.

When the forms for the piers were put in, those for the girders across the cistern were also placed, and both piers and girders were poured at the same time. The placing of the concrete in the molds is referred to as pouring because the mixture was very wet. Scarcely any ramming was done on the work, it being one of the clauses in the specifications that the concrete should be of such consistency as to require little or no ramming.

After the piers and girders had set the excavation for the cistern was completed, and the forms were set up for the walls. These forms, as intimated, were for inside of walls only, though the earth had to be shored up in places where it was inclined to cave in. The forms for walls did not include the chamfer at the junction of the walls and the bottom of cistern, as this was made with the bottom, giving a broader surface at the junction when the bottom was subsequently concreted.

It was the intention to have 1 in. of mortar on

*"Stahl und Eisen," May 30 and June 15, 1904.

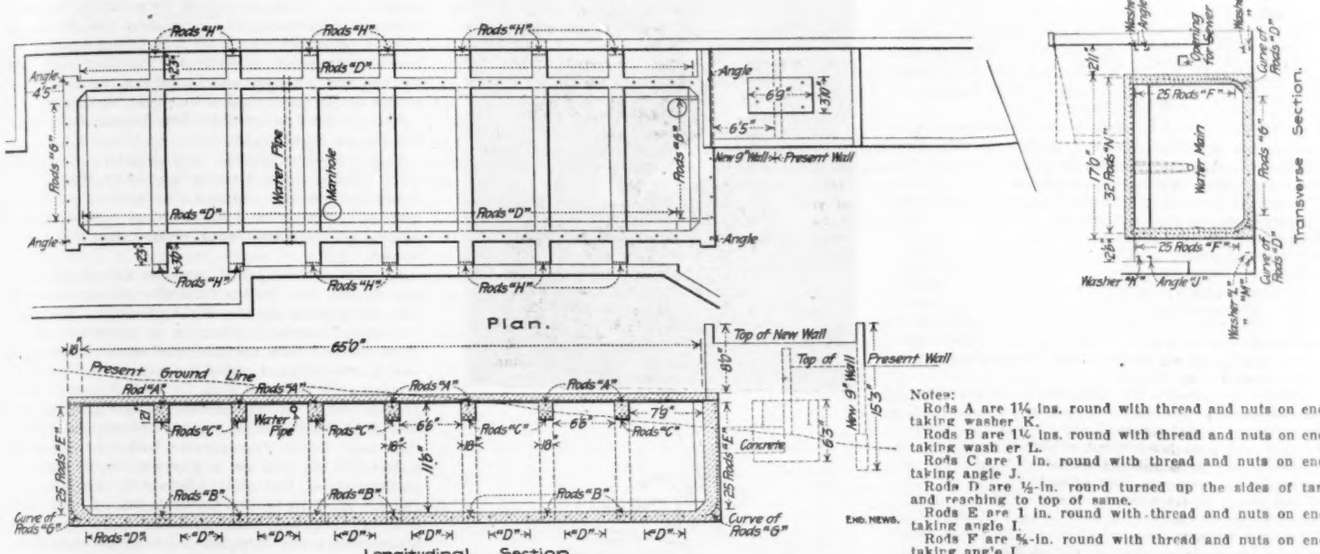
*Monongahela Bank Building, Pittsburg, Pa.

the inner faces of the walls and to build this up with the wall by the use of sheets of iron with cleats to keep them an inch away from the boards; the process being to fill in the space between the sheets and the boards and to draw the sheets up as the concreting progressed. This, however, was found to be impracticable under the circumstances, and was therefore abandoned.

The side rods were wired together at laps and were wired to the vertical rods sufficiently to keep them in place. The forms for the walls were put up a little in advance of the concrete, and temporary platforms were made at different levels, on which the concrete was wheeled from a tremie at the end of the cistern. A mechanical mixer dumped the concrete into this tremie.

The concrete was made of 1 part Portland cement, 2 parts river sand, and 4 parts gravel. A 1-in. layer of mortar, of equal parts of sand and cement, was placed on the bottom of the cistern in a manner similar to the placing of the finish on a granolithic pavement. When the forms for the walls were removed, many places were found where chunks of soil had fallen in; and when these were cleaned out, some good-sized cavities could be apparently all removed with a brush. The writer does not believe that this wash is responsible for the water tightness of the cistern. In any event if it should be shown that the cement wash is not sufficient in itself and that the lime and soft soap form crystals in the pores of the cement, as claimed, sealing them up; it is at least essential to use the cement to close up the holes in the rough concrete. It is possible that a happy combination of these two methods of waterproofing, one to satisfy the engineer and the other as a safeguard adopted by the contractor, have resulted in the attainment of a much desired object, namely, waterproofing that will prevent leaks in concrete, and that forms part of the concrete itself.

In designing this cistern it was made as though it rested upon the ground, the pressure of the earth around it not being counted upon to offset that of the water inside. The writer does not believe that earth that stands alone in a vertical wall 12 ft. high can be depended upon to exert an active force against a wall built in contact with it. At the same time provision was made for possible pressure of this soil when the cistern is



A 75,000-GALLON REINFORCED CONCRETE CISTERN FOR FIRE PROTECTION SERVICE, PITTSBURG LAMP, BRASS & GLASS CO., ALLEGHENY, PA.

Notes:

Rods A are 1¼ ins. round with thread and nuts on ends taking washer K.

Rods B are 1¼ ins. round with thread and nuts on ends taking wash er L.

Rods C are 1 in. round with thread and nuts on ends taking angle J.

Rods D are ½-in. round turned up the sides of tank and reaching to top of same.

Rods E are 1 in. round with thread and nuts on ends taking angle I.

Rods F are ⅝-in. round with thread and nuts on ends taking angle I.

Rods G are ¼-in. round turned up the ends of tank and reaching to top of same.

Rods H are ¾-in. round with thread and nuts on ends taking angle J and washer M.

Angle I is 3½ ins. × 2¼ ins. × ⅜-in. — 11 ft. 3 ins. long with holes punched for rods E and F.

Angle J is 3 ins. × 3 ins × ⅜-in. — 1 ft. 3 ins. long with holes punched for rods C and H.

Washer K is 4 ins. square × ¾-in. thick, punched for rods A.

Washer L is 4 ins. × ⅜-in. × 10 ins., punched for Rods B.

Washer M is 4 ins. × ⅜-in. × 1 ft. 3 ins., punched for rods H.

Rods N are ½-in. round, plain, running full length of cistern, midway between girders; all rods are ¾-in. from bottom of 4-in. slab forming roof. Over girders one-half of the rods are brought up to within ¾-in. of top of slab.

Rods will be in one piece where possible. If necessary to use more than one length, a lap will be made not less than 50 times the diameter of the rod.

Vertical rods in sides of cistern will be wired to horizontal rods sufficient to hold the latter in line.

were left. These holes were filled with cement mortar.

As stated, the work was done in cold weather. When the temperature fell below 20° F. the cistern was covered with boards, and two salamanders were employed, using coke, to keep the concrete from freezing.

To make the walls and girders watertight they were washed with three coats of neat cement to which water was added until the mixture was the consistency of thick cream. This was applied with whitewash brushes after the walls had been thoroughly wetted. It was found that if the mixture was too wet, it would crock; and if too thick, it could not be worked with a brush. Each coat was allowed 24 hours to set before the next was applied. The application of the first coat gave opportunity for seeing holes in the concrete that did not otherwise appear and these were plastered with cement as the brushing progressed.

After the cistern was filled with water and allowed to stand several days it was found that the level dropped about 5-16 in. per day. It is believed that this drop was due to water slowly rising in the spaces between the girders, as all but two of these are completely closed over. The cistern has been replenished but once since it was filled about four months ago, and that was after a test which used part of the water. The water level now remains constant.

It is fair to say that the contractors washed the inside of the walls with a mixture of hydrated lime and soft soap, as they believed that this would render it watertight. After this wash was on a few days it would rub off on the fingers or empty, the rods of the side walls being placed at the middle of the walls. The rod at the top flange of girders and the two at bottom of piers are to take the thrust of the side walls on the girders.

The writer, as structural engineer with Robert W. Hunt & Co., of Pittsburg, Pa., designed the cistern and supervised its construction.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS IN THE UNITED STATES.*

Electric lighting dates back only to the beginning of the last century, while the history of central stations proper belongs only to the second half or, more strictly speaking, to the last quarter of the century. The growth of this industry is shown by the following figures:

From 8 stations beginning operation in 1881 the number rose to 100 in 1886, to 208 in 1889, and to 247 in 1892. During the following years of depression the number of new stations fell; but in 1895, though a time of financial stringency, it again rose to 239. In 1898 it reached 277, or more than the number beginning operation in the entire period from 1881 to 1886, inclusive. The number for 1901 was 250, and for five months of 1902 it was 146. In the twenty years from 1881 to 1901, inclusive, an average of 165 private and municipal stations have begun operation each year. The spread of the agitation for municipal ownership of public service enterprises is illustrated in a somewhat striking manner. Of the 815 municipal stations enumerated, only 68 had been installed up to 1889. In that year 40 were introduced, and in 1895 the number of new stations reached 73, increasing in 1898 to 82. The returns for 1902 indicate that the ratio was fully maintained in the census year.

*Abstract from advance summary of report of Bureau of the Census, Department of Commerce and Labor, Washington, D. C.

In 1902 there were in the United States 3,620 central electric stations, with a cost of construction and equipment of $504,740,352. Employed were 6,996 salaried officials and clerks with salaries amounting to $5,693,580; and 23,330 wage-earners with wages amounting to $14,983,112. The gross income was $85,700,605; comprising $84,186,605 from sale of current and $1,514,000 from other sources. Total expenses were $68,081,375. The total output of stations for the year, in kilowatt hours, was 2,507,051,115. The number of arc lamps was 385,698 and of incandescent lamps 18,194,044.

There has been a striking change in the character of service in these stations. In the earlier days of the industry nearly all the stations were installed for the purpose of furnishing current for arc lighting, while to-day the bulk of current is supplied for incandescent lighting, motor power and miscellaneous service. This last includes charging telephone exchanges, batteries for boats and automobiles; pumping; hot water, steam and electric heating; electric current, and nickel plating and electroplating.

COMPARISON OF PRIVATE AND MUNICIPAL STATIONS.

Private stations form by far the largest portion of the industry, constituting 77.5% of the total number of stations in operation during 1902. Their income from sale of current was $78,735,500, or 91.9% of gross income, the expenses of operation 92.3% of the total, while they gave employment to 89.4% of the total number of wage-earners engaged in the industry and paid 90.5% of the total amount of annual wages. The primary power plant equipment of these stations formed 91.3% of the total horse-power of all stations, while their generating equipment formed 90.6% of the total horse-power of all dynamos. The kilowatt hour output of private stations formed 92.2% of the total, and the arc lamps in such stations formed 86.8% of the total number wired for operation.

The comparison of the income of the two classes of stations is not a fair indication of their earning capacity, because of the gross income reported for municipal stations. Of this gross income, $6,836,856 resulted from the sale of current and included income from public service which was necessarily largely, if not wholly, a matter of estimation.

The private stations employed 20,863 wage-earners, who were paid $13,560,771, and 6,046 salaried officials and clerks with salaries amounting to $5,206,199; while the municipal stations employed 2,467 wage-earners, who were

paid wages amounting to $1,422,341, and 950 salaried officials and clerks, who were paid $457,381.

The cost of construction and equipment of the municipal stations was only 4.4%; their income from sale of current, 8.1%; their expenses, 7.7%, and the horse-power capacity of their power and generating plants, 8.7 and 9.4%, respectively. The output of such stations was 7.8% of the total kilowatt hours produced by all the stations, while their arc lamps were 13.2% and their incandescent lamps, 8.7% of all the lamps reported for the country.

In addition to controlling practically the entire industry, the average private station is much larger than the average municipal station. Considering the total of 2,805 private stations, it appears that the average total expense per year per station was $22,401, as compared with $6,437 for municipal stations. The private stations gave employment on the average to 7.4 wage-earners, while the municipal stations gave employment to 3. The average private stations reported 823,938 kilowatt hours per year, as compared with 240,373 for the municipal stations.

It is found that 732 municipal stations operated in that number of communities in which there was no competitive private service. It would appear that in all probability a great many if not all of these places would have gone without electric lighting had the supply been left to private enterprise seeking a return upon its investment. The population served by these stations was 2,052,485, an average of a little over 2,800 per station, and towns of this size rarely offer inducements to private capital, regarded from the per capita basis of consumption of current. These stations also represent a total cost of construction and equipment of $15,369,382, or about $21,000 per station, whereas the average cost of construction and equipment for the 3,620 central stations of all classes was slightly short of $140,000.

DISTRIBUTION OF STATIONS.—The largest number of stations was in Illinois, followed by Pennsylvania, New York, Ohio, Michigan, Indiana, Iowa and Wisconsin in the order named. No other state reached the 150 mark. The New England states were well supplied with stations. Massachusetts reported the largest number, then came Maine, Vermont, New Hampshire and Connecticut. Among the Southern states Texas led, with Kentucky, Tennessee and Georgia following. Of the Western states, California reported the largest number of stations, Colorado, Washington, Oregon and Montana being next in order. Of the 1,892 places reported at the Twelfth Census as having a population of 2,500 and over, 1,511 had one or more central electric lighting stations. Of the places with a smaller population, 1,060 had similar stations.

LONG DISTANCE TRANSMISSION STATIONS.—A number of companies supply areas of many square miles in which are located scores of cities, towns, incorporated villages, and mere hamlets, all enjoying the benefits of electricity and constituting a source of income for the enterprise. The extreme limit of such work at the time of this report was marked by the long distance power transmission on the Pacific coast, where current from the Sierras was actually delivered for general consumption in San Francisco and Sausalito, and was also distributed from the same plants over lines which ramify into half the counties of the state of California. The whole aspect of central station current supply in its relation to population has in reality been utterly changed by the development of polyphase power transmission plants. There are at least a thousand such plants, with lines frequently 15 or 20 miles long, in many cases 40 or 50 miles, often 60 or 90 miles, and sometimes even 150 or 200 miles.

FINANCIAL OPERATIONS.

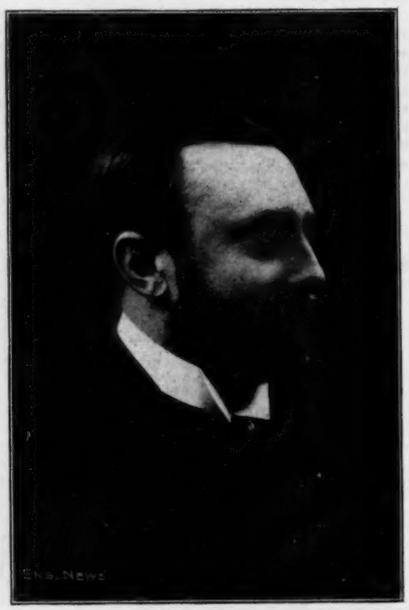
The total capital stock and funded debt authorized amounted to $743,296,266, but the amount issued was considerably less, being $627,515,875. Of the total amount authorized, $435,178,372, or 58.5%, was capital stock, and $308,117,894, or 41.5%, was funded debt. Of the capital stock issued, $23,871,671, or 6.4%, was preferred stock and $349,080,281, or 93.6%, was common stock.

Private stations expended $40,050,613 and municipal plants $1,741,834 in construction and equipment during the year covered by the report. The total for private stations from their origin until 1902 was $482,719,879, giving an average outlay of $328 per horse-power of dynamo capacity. It is interesting to compare these figures with those for municipal stations, which shows a cost for construction and equipment of $22,020,473, and an average of about $145 per horse-power of generating capacity; it is not safe to accept this average as a basis of comparison, on account of the wide variations revealed in the different states, which range from $114 in Ohio to $844 in the state of Washington.

Although the practice of supplying current for motive power and other uses had grown rapidly, the supplying of current for light was still preponderatingly the business of both private and municipal stations. Of the total income, $70,138,147, or 81.8%, was directly derivable from lighting. The private stations obtained 80.5% and the municipal stations 96.9% of their income from this source. This income from sale of current for lighting purposes was derived from 385,698 arc lamps and 18,194,044 incandescent lamps. The average income per lamp for arc lights in private stations and used for commercial or other private lighting was $48.88; used for public lighting, $83.20. In municipal stations, for commercial or other private lighting, it was $41.46; for public lighting, $69.98. The incandescent lamps in private stations in commercial use earned an average income of $2.40 per lamp; in public service, $6.06. In municipal stations these lamps earned $1.92 in commercial service and $5.93 in public service.

The total expenses for private and municipal stations were $68,081,375. Of this, $20,646,692 was for salaries and wages; $22,915,932 for supplies, materials and fuel; $11,895,206 for rents, taxes, insurance and miscellaneous expenses; and $12,623,545 for interest on bonds.

PHYSICAL EQUIPMENT.—This subject is considered under the three heads: Power and generating equipment, line construction, and service line equipment. The power plant equipment showed 5,930 steam engines with



1,379,941 HP. and 1,390 water wheels with 438,472 HP., and the generating plant equipment, 3,823 direct current constant voltage dynamos with 442,446 HP.; 3,539 direct current constant amperage dynamos with 105,531 HP.; and 5,122 alternating and polyphase current dynamos with 987,003 HP. The line construction had 107,263 miles of mains and 17,880 miles of feeders. For the service line equipment, meters, lamps and motors are the important items. There were 582,689 meters; 575,004 of these were mechanical and 7,685 chemical. The aggregate of arc lamps of all classes was 385,698, of which 334,903, or 86.8%, were operated from private stations and 50,795, or 13.2%, from municipal stations. In addition to these 385,698 arc lamps connected to the circuits of central stations, the street railways operating electric lighting stations reported 33,863 arcs, making the total for the United States 419,561.

BIOGRAPHICAL SKETCH OF PROF. J. KRAUS, C. E., MEMBER OF THE NETHERLANDS CABINET.

It will be remembered by some that in response to President Roosevelt's request to the Netherlands Government for the appointment of a representative on the Board of Consulting Engineers to the Isthmian Canal Commission, Prof. J. Kraus was named for the position. Just as he was about to sail for the United States, Professor Kraus was appointed a member of the Cabinet of the Netherlands, and so Mr. Johan W. Welcker came to this country instead. The elevation of an engineer to a Cabinet position is sufficiently rare to warrant the publication of some account of his life, were there not many other reasons for doing so, as is the case with Professor Kraus. Our biographical notes relating to Professor Kraus are based chiefly on a translation of an article which appeared in "Des Ingenieur" (No. 50, 1900) on the occasion of his appointment to the directorship of the Polytechnic School of the Netherlands. As will be seen, later inform[illegible] has been included.

Professor Kraus is a comparatively young [illegible] particularly for one so full of honors. He [illegible] born in 1862. At the age of twenty-one he gra[illegible]uated from the Polytechnic School of the Net[illegible]lands, at Delft. After laying out a branch [illegible] of the Dutch State Railroad and installing [illegible] heating apparatus, oil-gas works and wa[illegible] works for the State Insane Asylum, he was [illegible] engaged on cutting the Almelo-Noordhorn C[illegible]

In 1886, Mr. Kraus was named assis[illegible] teacher in hydraulics at the Polytechnic Sch[illegible] and it was while filling that position that he contributed to the columns of "De Ingenieur" and "of the Journal of the Royal Institute of Engineers." The review of technical periodicals published in the "Journal" was under his editorship during this time.

After a brief period of private engineering practice, Mr. Kraus left for Chili early in 1890 to accept the chair of hydraulics in the University of Santiago. His capacity and adaptability for this important post soon received due recognition by the Chilean Government in the form of an engagement not only for the construction of a dry-dock, but also for the harbor works at Talcahuano, for which enterprise he received the appointment of managing engineer. At the conclusion of these labors he was commissioned by the Government to visit the leading ports of Europe and America and to inspect the important works under construction in both Continents.

Upon returning to Chili, Mr. Kraus supervised the carrying out of the main portions of his Talcuahano harbor plans. The portions executed were chiefly those bearing upon the Marine Installation, as the Chilean Government was unable to come to a final decision regarding the outlay of the large sum needed for the entire works.

Mr. Kraus was called upon to act as advisory expert, not only for the foregoing enterprises, but also for nearly all the ports of Chili. Notwithstanding, however, his having so thoroughly identified himself with his sphere of action in the new world, he could not resist the call from his native land which brought him, in 1898, an offer of a professorship in hydraulics at the Polytechnic School of Delft. It was with undisguised regret that the Chilean Government bade him farewell, conferring on him as a parting honor the appointment of technical advisor in Europe and Consul of Chili in the Netherlands. A year had scarcely elapsed during which time Professor Kraus had given palpable proofs of his rare pedagogic tact and capacity, when he was named by the Government of the Netherlands to form part of the Advisory Commission for the different harbor and maritime works in the Dutch East Indies. His efforts there were again deserving of the highest praise, and as a result the order of the Lion of the Netherlands was conferred upon him.

In 1900 the Government of Chili once more offered him the professorship of hydraulics at Santiago, and this time under even more favorable conditions than in 1890, but Professor Kraus withstood the most tempting inducements and remained faithful to his post at Delft. This constancy was rewarded in a twofold manner, for not only has Mr. Kraus been made Director of the Polytechnic School, but he has had the satisfaction of seeing that same school raised to the category of an Engineering Academy. On this occasion the title of Rector Magnificus was bestowed on Professor Kraus in acknowledgment of his exceptional talents as an engineer and as a director. This distinction of Rector Magnificus was enhanced by the Commander's Cross of the Order of Orange-Nassau, which was awarded him by her Majesty Queen Wilhelmina, and is considered to be a most signal honor, as it is granted to but a chosen few in the realm of science and letters.

The latest engineering work undertaken by Professor Kraus was the plans for the dock and final quaywall for the harbor of Valparaiso. The plans were drawn up by the order of the Chilean Government, and they were the results of minute and protracted studies carried out by Professor Kraus on the site itself. They have been accepted by the Government of Chili and are to be contracted for in April, 1906.

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Various newspaper reports are being published pretending to forecast the position of the Panama Canal Advisory Board upon the question of the sea-level plan. It is alleged, for example, that the foreign members of the Board appear to favor a sea-level canal and that they may cast the deciding vote on this momentous question. It is a pretty safe assumption that all such forecasts are based on the reporter's desire to furnish a news item and not on any actual expressions of opinion. It is not at all likely that the members of the Board will commit themselves to any expression of opinion prior to the completion of the studies in which they are now engaged, or that when they arrive at a decision they will communicate it to the daily press reporters prior to its official publication.

Similarly the stories that the Administration is committed in advance to the one plan or the other may be set down as mere guesses. It is officially given out in fact that President Roosevelt, when he received the members of the Advisory Board at Oyster Bay recently, spoke as follows on this question:

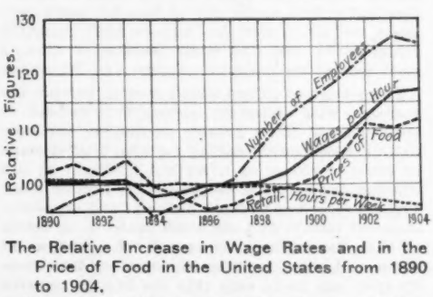
> I hope that ultimately it may prove possible to build a sea-level canal. Such a canal would undoubtedly be the best in the end if feasible; and I feel that one of the advantages of the Panama route is that ultimately a sea-level canal will be a possibility. But while paying due heed to the ideal perfectibility of the scheme from an engineer's standpoint, remember the need of having a plan which shall provide for the building of a canal on the safest terms and in the shortest possible time. If to build a sea-level canal will but slightly increase the risk, then, of course, it is preferable. But if to adopt the plan of a sea-level canal means to increase our hazard and to insure indefinite delay, then it is not preferable. If the advantages and disadvantages are closely balanced I expect you to say so. I desire also to know whether, if you recommend a high, level, multi-lock canal, it will be possible after it is completed to turn it into or substitute for it, in time a sea-level canal, without interruption of the traffic upon it. Two of the prime considerations to be kept steadily in mind are:
>
> (1) The utmost practicable speed of construction.
>
> (2) Practical certainty that the plan proposed will be feasible, that it can be carried out with the minimum risk.
>
> The delay in transit of the vessels, owing to additional locks, would be of small consequence compared with shortening the time for the construction of the canal or diminishing the risks in its construction.

This is sound common-sense and neither the advocates of a sea-level or a lock canal can take exception to such a position.

Since the above was in type we have received from our Washington representative a report of a special interview with General Davis, fully establishing the position taken by us in the above note. The report of the interview follows:

> General Davis, Chairman of the Board of Consulting Engineers, briefly outlined on Sept. 25 the results of the sessions of the board held during the past ten days:
>
> The work done has been merely preliminary. The board has discussed in full the various types of canal advocated, the sea-level, the low-level with few locks and the high-level with many locks, including the plan of Mr. Linton W. Bates for constructing a large lake at each end and lowering the Culebra cut, and that of Mr. Bunau-Varilla for the immediate construction of a high-level canal and its ultimate alteration into a sea-level canal by dredging. The board has examined further all reports in full from the Isthmus, studied the conditions there and the engineering difficulties to be encountered as well as they could from the material at hand. They have, however, come to no conclusion regarding the type of the canal that they will recommend, for such was not their intention. Any newspaper statements therefore that claim that the board has determined on any particular plan are without foundation.
>
> The board proceeds to-morrow to Boston to examine the dams at the Wachuset Reservoir and on Thursday sails for Colon, where they will remain for a week and examine every spot on the Isthmus ever suggested by any one as available for the construction of the canal. They will continue their sessions during the trip down and back and during their stay in Panama. They have ordered to be prepared in their absence accurate drawings of every type of canal suggested for the Isthmus and will have these on their return. It is likely that some time will elapse before a definite report is made to the President.

The U. S. Bureau of Labor has been engaged for some time in the collection of statistics relative to changes in rates of wages, in average hours of labor and in the cost of living. The result of this investigation (which is still in progress) are now beginning to be published and there lies before us a ponderous volume of about 1,000 pages, nearly the whole of it made up of closely printed tables. The mass of data presented is so voluminous that we feel safe in saying that no one, with the possible exception of an occasional special student in sociology, will ever attempt a detailed study of these figures. What the average busy man wishes to know at once is, what are the main facts revealed by the inquiry? We have looked in vain in the volume for any condensed and clear summary of what has been learned as a result of this elaborate investigation—such a summary, we mean, as the busy editor of a newspaper or technical journal can sieze upon and lay before his readers. We have also received from the same bureau, however, a later bulletin bringing this investigation down to July, 1905, and in this



The Relative Increase in Wage Rates and in the Price of Food in the United States from 1890 to 1904.

(From Bulletin No. 59 of the U. S. Bureau of Labor: The average for the years 1890 to 1899 is taken as 100 in plotting the lines.)

volume we find a diagram which conveys just the information we wished to find and in a form that enables it to be comprehended almost at a glance, at least by the engineer accustomed to reading diagrams. We reproduce this diagram herewith. The striking thing which it shows is that the steady rise in the average wage rate that has been going on since 1894 has been closely paralleled by an increase in the cost of food. There has been also since 1898 a steady reduction in the average hours of labor performed per week. This partly offsets the increase in the wage rate per hour, so that if a line were drawn on the diagram representing the weekly earnings of workmen, it would follow even more closely the line representing the increased cost of the workman's food. The line at the top showing the change in the number of workmen is somewhat misleading since it shows not the total number of workmen employed in an entire industry but only the relative number employed in the particular establishments investigated. Nevertheless, it is probable that these establishments are representative of the entire industry and that the line at the top is fairly indicative of the increase in the number of workmen employed that has taken place since 1894.

A significant event of the past summer is the recent action of the American Society for Testing Materials in adopting a set of constitutional amendments that cut the last bond of dependence upon the International Association for Testing Materials. By these amendments the society ceases paying to Vienna a poll-tax of $1.50, and its members will no longer be ipso facto members of the International Association. Instead, the payment of a lump annual contribution of $100, giving the society the position of Contributing Member in the International Association, will retain for the society a deliberative participation in the proceedings of the latter.

The adoption of these amendments, accomplished (but for the formality of a letter ballot recently concluded) at the annual meeting of the society last June, is the logical sequel of the movement which organized the American Society for Testing Materials out of the small and sickly American Branch of the International Association for Testing Materials. The science and art of testing had, in America, grown to be an essential adjunct of both manufacture and construction. Correspondingly, the testing engineers had increased in number until they had come into a recognized position among engineering specialists. There was need, then, of an organization which would bring these engineers together for discussion of their common problems and for joint action and mutual benefit. The American branch of the International Association for Testing Materials, organized some years earlier, could not give him those facilities. Its objects and program of work, determined necessarily in close parallel with the program of the parent organization, did not meet his most immediate needs: as for instance, the development of national standards and tests for important industrial products. And while, perhaps, the existing Branch could have been modified so as to more closely approximate the desired functions, yet the nature of its relation to the International Association would have made it at best an inefficient and uneconomical machine for the desired work. The result was inevitable: the formation of a new society, of such purpose and scope that testing engineers would obtain the mutual benefits in view. That this new society came into being as the successor of the previous branch organization is a minor detail; the need for the new society was independent of the existence of the other organization, and the latter merely served as a scaffolding for the erection of the other. The only feature of this method of building the new society that has bearing here is that the society assumed the future liabilities and privileges of its predecessor, by continuing the payment of the $1.50 poll tax to the foreign organization, even though to do this it embarrassed its own work by reducing its income. The temporary, transitional nature of this arrangement is evident; it could not last, unless the returns from the payment were such as, independently, would warrant the society in undertaking it as an investment advantageous to its members. Such returns not appearing, as is the fact according to the last two reports of the Society's Council, the termination of the tribute-paying arrangement was merely a matter of time. The growing financial needs of the society's own work, even a year ago, made it evident that that time was in the immediate future. The present abrogation is, therefore, merely a delayed step in the process of formation of the society.

The American Society for Testing Materials, already one of the most successful technical organizations in this country, has a future of great promise. Besides the study of methods and means for testing, it cultivates two inter-related fields: first, the study of properties of materials and how these are affected by various factors, such as impurities, process of manufacture, etc.; and second, the standardization of specifications for materials. Its work in these fields is designed to promote reliability and cheapness of materials (and therefore of all engineering work); indirectly it promotes public safety and public welfare. The society has enlisted in this work the active interest of engineers, manufacturers, and engineering scientists, to a gratifying extent. With such an equipment and such objects, the society is surely of sufficient weight to stand alone, without leaning on a foreign organization, the more so as its work is primarily of national interest and has less importance beyond the Atlantic. More than this, affiliation with a body

ambitious to serve international needs would even be a distinct disadvantage to the Society's work, giving a misleading international aspect to problems that should be worked out with regard only to home conditions. On every ground, therefore, the Society is to be congratulated upon its assumption of complete individuality, with enlarged possibilities for future efficiency.

The failure of the International Association for Testing Materials to retain the permanent active cooperation of American testing engineers may well be looked upon as a matter of some concern. If the view be confined to that Association alone, the matter is of little moment; we see no reason to believe that separate national or local bodies in the field of testing and related work, harmonized as they would be to some extent by their printed transactions and by reports of their work in technical journals, could not accomplish as much as an international organization, for the same expenditure of energy. But the International Association for Testing Materials is only one of a number of international technical organizations, each of which absorbs a certain amount of energy from the resources of the technical world. And, as the causes responsible for the Association's present dormant, perhaps dying, condition are not entirely peculiar to the Association alone, doubt arises as to the virtue and efficiency of other international bodies.

Directly, we take it, the International Association's condition is to be charged to its loose and inefficient structure, and to a lack of business energy in its direction. But even with these factors eliminated, what results would have been obtained? A society stretching over half the world's circumference, and handicapped by the polyglot character of its membership, is necessarily cumbrous, slow-moving and inefficient. Meetings could be held only at long intervals, while distributions of printed literature, laboring under the requirements of translation into several languages, would be little better for carrying on its business. Moreover, the interests of the various parts of the society would not be identical, except perhaps those interests which are purely scientific; the problems of France would hardly be those which Sweden at the same moment had to deal with. In short, the results attainable would, even with excellent form of organization and sagacious, energetic management, be disappointing. Progress would be made only in those phases of the general subject which depend for their treatment upon joint international consideration.

In recent years much activity has been observable in the direction of forming international associations in this or that branch of engineering or semi-technical work. The call to get on the international band-wagon has been heard again and again. What is the inherent merit of this movement? The downward progress of the International Association for Testing Materials throws some light on this question. Incidentally it also carries warning to the promoters and managers of international technical associations that technical eminence in the directing board is not the only requisite for success.

SHALL WE SUBSTITUTE IRON FOR STEEL?

As many of our readers will recall, we published two years ago articles from a large number of different contributors describing experience with iron and steel pipe and with other articles made of iron and steel, which showed apparently that steel corrodes much more rapidly than iron. We present in this issue considerable additional data from a discussion at the Washington meeting of the American Institute of Mining Engineers (the report of which has just become available for publication). This discussion confirms the opinions previously expressed and goes still further in showing the rapid rate of corrosion of much of the steel made at the present day.

The Department of Agriculture at Washington is proceeding with an investigation as the result of complaints by farmers throughout the West who declare that their wire fences, which were formerly good for thirty years of life, now begin to fail by the end of three years. Steel wire nails, steel plates, coated with tin and used for roofing, steel boiler tubes, and steel structural material are among the other products concerning which complaint is heard because of the rapid rate of corrosion.

It is to be noted also that the importance of corrosion and the limitation which it sets to the life of a structure are just beginning to be fully appreciated by engineers, and in a lesser degree by those who employ engineers. Forty years ago it used to be considered that a wooden bridge was a temporary structure and an iron or steel bridge a permanent one. But there are wooden highway bridges still standing and in good condition in this country which were old structures when steel highway bridges first became common, and which have witnessed already the final end of many of these same steel bridges. Of course the great cause—and the one usually assigned—for the replacement of an iron or steel bridge is that the traffic has outgrown its capacity; but it is also true in most cases that corrosion has greatly reduced the original strength. Who can doubt that the engineers who built the iron structures that were erected forty years ago, or at least those who paid for them, would be disappointed to-day to realize how poorly their work on the whole had withstood the ravages of time and how nearly it had reached the limit of its life.

We at the present day have the advantage of experience which they lacked. We can estimate closely—or ought to be able to—a rate of annual depreciation, where they could only guess, and it is an important question whether even more attention ought not to be given to the matter of durability and resistance to corrosion in the design of all sorts of engineering work.

Unquestionably this is already being done, to a large extent. The enormous use of concrete, and of reinforced concrete, and the renaissance of the masonry arch, are evidence that durability counts for more than cheapness of first cost with many users and their engineering advisers; but unless all our information is at fault we ought to go farther and return to the use of iron for many purposes for which steel has become the customary material, or else find some method of making steel reasonably resistant to corrosive influences.

There are two things which greatly hamper the engineer who wishes to employ iron instead of steel because of its greater durability. He may write a specification calling for iron pipe or nails or plate or sheets or wire; but how can he tell whether the material he receives is iron or steel, without resorting to some difficult and expensive chemical tests? And the retail dealer is no better off than the engineer, or as well off, perhaps. In the second place, suppose the engineer does specify iron, can he be sure that the iron he receives will be a satisfactory material. Iron fresh from the puddling furnace is used for selected brands of boiler flues, stay-bolts, etc., but more or less of the wrought iron of the present day market is made from scrap. The constituents of the scrap pile from which that iron was created are so varied and there is such large chance of steel forming part of it and introducing the probability of non-homogeneity and flaws that the engineer may be excused for hesitating before he demands iron instead of steel.

Clearly, then, the increasing use of wrought iron is closely dependent on a reliable supply of wrought iron produced from the ore, but the difficulties in the way of re-establishing the old hand puddling system are many. A mere comparison of the interior of an old-time puddling mill and a modern open-hearth steel furnace plant will show that the one represents a maximum of hand labor while in the other machinery intelligently controlled has largely replaced human muscle. In order that wrought iron may come into much more extensive use, some process is needed by which wrought iron can be produced on a large scale, with the minimum of hand labor and with a product equally reliable to that produced by the old method. A process which appears to fulfil these conditions is that invented by Mr. Jas. P. Roe, of Pottstown, Pa. and described in a paper published in our issue of May 7, 1903. The expert comments on Mr. Roe's process made at the Washington meeting of the Mining Engineers were highly favorable and certainly indicate that a way has been found whereby wrought iron can be produced at as low a cost as good steel.

Of course steel may be expected to hold its present place in many fields and probably most. Wherever hardness and resistance to abrasion are important qualities, as in railway rails, it is of course infinitely superior to wrought iron. Wherever facility of welding or resistance to corrosion is an important factor, the superiority of wrought iron must be admitted.

A question of much interest in this connection and one which is still unsolved relates to the cause of corrosion in steel. Cast iron is known to be more resistant to corrosion than either wrought iron or steel. In the early days of the Bessemer and open-hearth process it was naturally supposed that its product, being intermediate in its carbon content between cast and wrought iron would be also intermediate as respects susceptibility to corrosion. It was not until years of experience with very soft steel had been obtained that the greater liability of steel to corrosion was definitely determined. Even now it is possible to find engineers who maintain that steel resists corrosion as well as wrought iron. It is not long ago that there came to our notice in the advertising literature of a wire manufacturer the claim that the fence wire now made was as good as that ever produced, and that the reason the wire corroded so much more rapidly than formerly was the greater amount of gas in the air due to the increased consumption of coal in locomotive and other boilers!

As to the real reason why soft steel corrodes so rapidly, engineers and chemists are, so far as we are aware, almost wholly in the dark. It is of course quite within the possibilities that the cause may yet be discovered and that it may then prove feasible to so alter the chemical constitution as to make the steel longer lived. Certain alloys, nickel for example, are known to greatly increase the resistance of steel to corrosion; but their cost makes their extended use quite out of the question. Phosphorus is also believed to increase resistance to corrosion; but its favorable influence in this direction is far more than counterbalanced by its injury to the physical qualities.

These problems, however, must be left to the chemists. Until they are solved the engineer who considers the durability of a structure exposed to corrosive influence will prefer wrought iron to steel.

LETTERS TO THE EDITOR.

Metes and Bounds as Defined by a Maine Deed.

Sir: Perhaps some of your readers may be interested in the accompanying extract from a deed which I recently came upon in searching out a boundary.

Yours truly, O. H. Tripp.

Rockland, Me., Sept. 18, 1905.

Jacob S. Ulmer,	East Lincoln Registry Book 32, Page 1,
to	Warranty Deed
	Dated Jan. 1, 1857;
Mary E. Farrington,	Acknowledged Jan. 1, 1857, Before Knott C. Perry, Recorded Nov. 25, 1859.

Conveys

A certain lot of land situated in Rockland and bounded as follows, to wit: Westerly by the county road, southerly by the northerly line of Jacob Ulmer's house lot, easterly by the easterly side of a range of poor lime rock at the western end of the lime quarries owned by several persons whose quarries are bounded westerly by said poor rock, consequently the gore of land hereby conveyed runs to a fence, thence by said fence northerly to the county road, containing one acre.

The Collapse of a Department Store Building at Albany, N. Y.

Sir: I have read your article, "The Collapse of the Department Store Building at Albany, N. Y.," and your editorial on the same subject in your issue of Sept. 7. In behalf of myself, as contractor for the work of constructing an extension of the sub-basement in the Myers store, and my superintendent, Mr. Daggett, I merely wish to state at this time that the conclusions arrived at in your articles are based largely upon suppositions as to what might have occurred to cause the collapse of the building, and until the suppositions upon which the conclusions have been based up to this time have been proved before a court, I would respectfully request a suspension of judgment as to the cause of this deplorable catastrophe. Yours very respectfully,

John Dyer, Jr.

Albany Trust Building, Albany, N. Y., Sept. 18, 1905.

Waterproofing the Pennsylvania R. R. Tunnel at Washington, D. C.

Sir: Referring to the article in your Sept. 14 issue, entitled "The Pennsylvania R. R. Tunnel Under Capitol Hill, Washington, D. C.," you will permit us to call your attention to an error in the second paragraph, under the subhead, "Description of tunnel," in which you say, in referring to waterproofing: "On top of the concrete covering there is laid a waterproof coating, consisting of alternate layers of coal tar, pitch and Hydrex Felt." It should be, not coal tar pitch is being used, but "Hydrex Compound" and Hydrex Felt. Believing you wish the record to be correct and in justice to our materials, we bring to your notice this error. In a low temperature in such a tunnel considerably underground in clay formation, the Hydrex Compound is designed to remain always elastic and pliable, while coal tar pitch under the same temperature would, for the purpose, be too hard and brittle.

Very respectfully yours,
Hydrex Felt & Engineering Co.,
Edw. W. DeKnight, Manager.

New York, Sept. 15, 1905.

Stresses in Viaduct Columns Due to Braking of Trains.

Sir: I was very much interested in the article "Track Elevation on the C. & N. W. Ry" which appeared in Engineering News of Sept. 7.

Just one question of mine about the stress in the structure of the subway bridges on that work: Since there is no allowance for impact, how is the longitudinal stress, caused by braking of trains on the bridge, supported by the steel bents? It may not be common to apply the brakes while train is passing over bridge, but it is quite reasonable to consider such a possibility. I think that, specially in elevated steam railways, where loads are heavy, this longitudinal force gives a considerable amount of bending stress to the bents. Assuming the frictional coefficient between train and rails, while braking, to be one-fifth, the bents must stand a lateral pull at top equal to one-fifth the loads on bridge, the bents acting as a cantilever beam.

I wish to know what is the general practice in this country concerning provision for this longitudinal stress on bents of elevated railways, mainly caused by braking of trains.

Yours truly,
K. Okma.

Engineers' Camp, Antoine, Ark., Sept. 15, 1905.

(Stresses which may be caused by the longitudinal traction of braked trains are in good practice provided for just as completely as wind stresses. This applies to piers or viaduct towers as well as to bridge spans. In the case of a short crossing like that referred to by our correspondent, it may not be necessary to make any provision in the structure for such stresses, as the rails may be counted on to transmit a very large amount of longitudinal stress over the short distance in question. If the longitudinal loads be assumed to be resisted wholly by the columns, these being fixed at the top and at the base, calculation shows a bending stress in the column twice as great as the main compressive stress, even in the favorable case of a crossing of minimum height.—Ed.)

MONTREAL'S MUNICIPAL ASPHALT PLANT.*

By John R. Barlow, M. Can. Soc. C. E.†

The defective condition of many of our asphalt paved streets rendered it absolutely necessary that the city should be in a position to control the situation without being at the mercy of the contractors. In the spring of 1903 the City Council authorized the Roads Committee to call for tenders for the supply and erection of an asphalt plant and complete equipment. The tender price of Messrs. Warren Brothers, of Boston, Mass., namely $13,000, was accepted and the contract awarded in April, 1903. The plant was installed and operations were begun in June of the same year.

The plant's capacity is 1,000 sq. yds. of 2-in. topping per diem. The following is a general description of the plant:

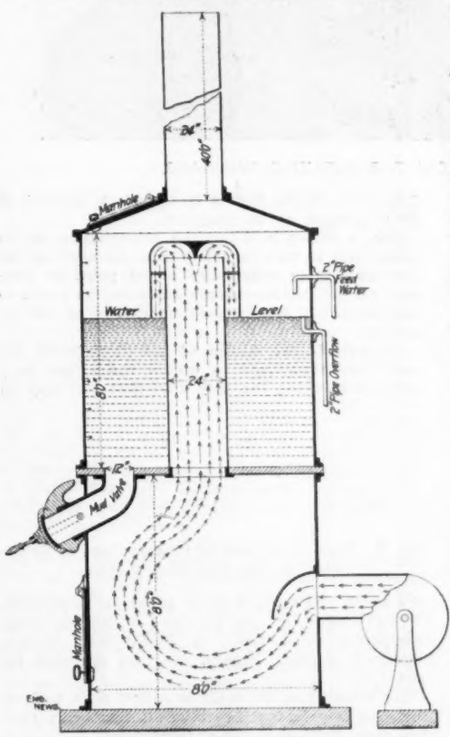
The sand dryers consist of double 40-in. cylinders of 19 ft. 6 ins. length, provided with an exhaust fan for furnishing induced draft. These dryers are self-contained, having a steel casing and a double steel roof with an air space between to prevent loss of heat by radiation. The inside of the casing is lined half way back with special extra heavy fire bricks and the dryers are fitted with grates having an area of 40 sq. ft. The dryer is so arranged that the heat passes around the outside of the cylinders and then back through their interior, which allows the heat to come into contact both with the steel shell and through the sand itself, which is kept constantly dropping through the hot gases. The hot sand is elevated by means of a continuous elevator to a revolving screen which can easily be shifted out of the way in case it is desired to run binder.

The bin and mixer are compactly arranged so that the hot sand or stone can be drawn by gravity into the weighing box and from there into the mixer without having to handle it in any other way. The mixer is elevated so that the teams can back without hindrance.

The whole structure is built of steel, with the exception of the floor, thus securing a perfectly rigid structure which is not affected by shrinkage.

The two melting tanks hold 1,400 [Imp.] gallons each. A most important feature of the plant is the independent trackway which carries the asphalt bucket, by reason of which the jarring and vibration of the machinery is entirely eliminated from the delicate scales on the asphalt bucket, making it possible to weigh accurately the asphalt for each batch. The power is supplied by a 35 HP. engine. The engine and boiler are mounted together in a room separated from the rest of the plant so as to avoid damage from dust.

The apparatus supplied by the contractors for the purpose of collecting the dust did not prove to be satisfactory on account of the large quantity of dust which escaped with the smoke. This dust caused a great deal of annoyance to the workmen and residents in the neighborhood of the plant. In order to overcome the difficulty, the engineer in charge, Mr. N. Cyr, devised and built a steel dust collector, which effectively prevents the dust from escaping, and works in a very satisfactory manner. The original dust collector was enclosed in canvas, and the improved dust collector referred to above is made of steel, and the dust and smoke is led into a tank of water where the dust is precipitated by contact with the water.



Dust Collector for the Montreal Municipal Asphalt Plant.
Napoleon Cyr, Inventor.

In addition to the tools necessary for the operation of the plant, the contractors were required to furnish the following tools for street paving purposes:

1 five ton steam asphalt roller.
1 fire wagon.
1 pitch kettle.
6 asphalt rakes.
6 asphalt tampers.
6 asphalt smoothers.
3 double-eye asphalt cutters.

The whole work of erection was completed in a first class manner by the contractors, and the repairing of asphalt pavements immediately started by the city.

The entire plant, with the exception of the engine and boiler, is under one roof, and the building is quite large wherein ample quantities of raw material is kept on hand. The city has since acquired an additional melting tank and duplicated all the above-named tools, and keeps two gangs of men.

During the first two seasons there were 51,080 square yards of repairs and new work done by the city; the new work consisted chiefly of repaving streets, formerly paved with 3-in. tamarack blocks which were worn out. The average cost of the asphalt laid was $1.22 per sq. yd., and this figure includes all works in connection therewith.

When the asphalting work is suspended on account of wet weather the old asphalt taken from the streets is ground in a mill and prepared for use in the construction of coal tar composition sidewalks, so that no time is lost.

The city is this year making experiments with different brands of asphalt, and hopes by next year to be in a position to determine which kind of asphalt is best suited to the conditions of our climate, and also to be able to ascertain the area that a ton of each kind will cover, together with the cost per square yard.

The total cost of the civic asphalt plant, including buildings erected in the Corporation yard, tools, repairs, etc., has been to date $22,881.35.

The approximate total area of pavements of all kinds in the city is 745,223.75 sq. yds., or 31½ miles. Two-thirds of this is now under the city's charge for repairs, and the balance is still under guarantees which expire yearly up to 1910.

In view of the fact that the city now has more than 500,000 sq. yds. of permanent ways to keep in repair, the importance of possessing adequate means to maintain the streets in good repair cannot be exaggerated, and the results obtained with the civic asphalt plant has amply justified the expenditure the venture entailed, as it only has the work been done more economically and promptly, but it has been done in a more thorough and satisfactory manner than when done by contractors.

*A paper read at the Montreal Meeting of the American Society of Municipal Improvements.
†City Surveyor, Montreal, Canada.

ASSESSMENTS FOR LOCAL IMPROVEMENTS IN NEW YORK CITY.

Assessments for benefits is one of the most perplexing subjects which presents itself to the city official who seeks justice tempered with mercy. This is particularly true when such an official approaches his problem with an intelligent endeavor to base his ideas of justice upon scientific principles instead of precedent and sentiment. It would not be far from true to say that in practice, minor variations considered, there are as many methods of making assessments as there are cities. Some of the details of practice in New York City were presented in a paper read before the Montreal Convention of the American Society of Municipal Improvements, held Sept. 5 to 9, 1905. The paper was by Mr. Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment, New York City.

For assessment purposes New York City is divided into 25 local improvement districts. The aldermen in each district compose a local improvement board. Each borough president is a member and is the presiding officer of each local board. Petitions for assessable improvements are addressed to the proper borough president, who gives notices of public hearings. After the hearing, if the local board approves the petition, the latter is referred to the board of estimate and apportionment (of the whole city.—Ed.) for approval or refusal. If approved, contracts are awarded by the borough president. In the case of acquiring titles to streets, however, the corporation counsel, instead of the borough president, takes up the project, applying to the courts for commissioners of condemnation, estimate and assessment. Petitions for improvements need not be signed by abutting property-owners nor by any specified number of people.

Many abuses are perpetrated in connection with property-takings. The commissioners of assessment, being paid $10 per day per sitting, manage to "sit on" many cases in a single day and protract the hearings without conscience. Temporary buildings are placed in the way of proposed streets and abnormal values for them are allowed. The buildings are afterwards put up at auction, bid in for a nominal sum by the owner, then moved on and used again in the same scandalous way. To avoid such abuses an effort has been made to secure legislative authority for a permanent commission of awards to consist of competent, well paid men, but thus far this effort has been unsuccessful.

The board of estimate and apportionment decides what portion of the cost of a local improvement shall be borne by the city at large. In the case of street openings all streets 60 ft. or less in width are assessed wholly upon the abutters. For streets more than 60 ft. wide the city bears one-third of the cost of acquiring the property for the excess portion. In widening, the city pays one-half of the cost of the portion over

60 ft. wide, but if the street is only 50 ft. wide the property-owners must stand the cost of a width of 10 ft.

The city charter prohibits levying an assessment for a single improvement in excess of one-half the "fair value" of the abutting property. "Fair value" is usually held to be assessed value. Recently assessed valuations have been raised from about half to full actual value.

In concluding his paper, Mr. Lewis spoke of the difficulties involved in fixing assessments for benefits due to great public improvements, such as new or widened streets leading to bridges. Individuals and local boards are loath to present or forward petitions in these cases, thus throwing or tending to throw the whole cost upon the city, although large local benefits arise. It was suggested, as in many respects desirable, although hardly practicable in American cities at present, that the city buy property abutting on the improvements, thus gaining for itself by reselling later on, the benefits of increased valuation really due to improvements made by the city at large. This has been successfully done abroad and is now being done in the case of the Strand improvements in London.

A NEW SNOW-PLOW FOR ELECTRIC RAILWAYS.

The snow-plow shown in Fig. 1 has been used for two winters on the Worcester Consolidated Street Railway, and one winter on the Boston & Worcester Street Railway. The photograph shows the plow rounding a curve, and it will be noted that the cutting edge of the plow is directly over the rails. This is the special feature that distinguishes this plow from others previously used. Fig. 2 shows the position of the ordinary type of snow-plow fastened to the body of the electric street car. Fig. 3 shows the position of the new plow, known as the "Wilder Radial Snow-plow." The Wilder plow is mounted on the trucks of the car, and not on the body of the car, hence its cutting nose lies in the radius of any curve that the plow is operating upon.

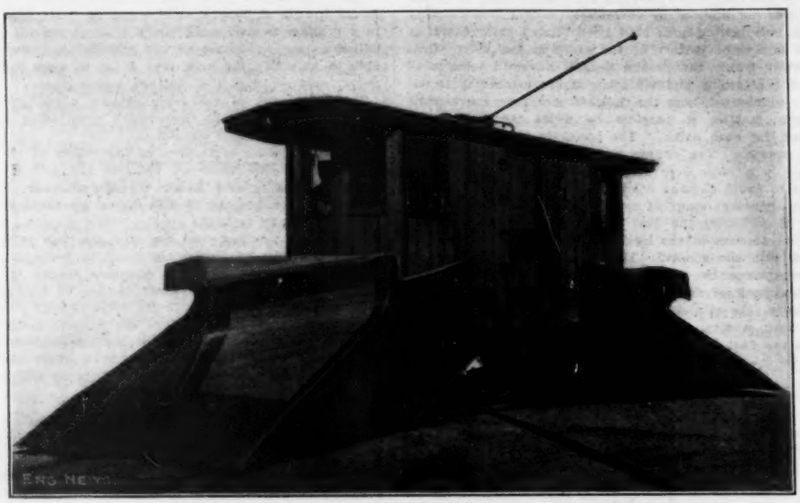


FIG. 1. A NEW SNOW-PLOW FOR ELECTRIC RAILWAYS.

The snow on the curves is, therefore, cleaned off as effectually as on tangents.

Fig. 4 shows in detail the construction of the plow, and it will be noted that the body of the car terminates practically at its point of support on the trucks, thereby allowing the plows to turn with the trucks even on curves of 25 ft. radius.

As regards the design of the plow itself, the well-tried type used by steam roads has been adopted as being the only kind that will stay on the track and remove snow under all conditions.

The weight of the car and plows (without equipment or ballast), is 36,000 lbs. Wings, scrapers, sanders, brakes, etc., are operated by air.

The framing of the body is yellow pine, and of the plow is oak; the sheathing all over being yellow pine, finished in the natural wood.

Each end of the plow is supplied with a "Huff" two-way locomotive air sander; also a 3-in. chime whistle, and a 12-in. gong is located under each hood.

The equipment used on the Worcester Consolidated plows consists of four G. E. 67 motors, with K-6 controllers; and on the Boston & Worcester, four G. E. 57 motors with K-14 controllers. The plow, however, is designed to take motors as heavy as 125 HP.

On the Worcester Consolidated, it is stated that the plow averaged twice the mileage per hour averaged by all other plows, many having better equipment. It kept its lines open when many others were tied up, and was sent repeatedly to open blocked lines, and release stalled and derailed cars and plows.

With its light equipment it maintained a speed of over 8 miles per hour for miles, through snow that averaged from 1 to 3 ft. in depth, frequently taking side-hill drifts 3 to 5 ft. on the high side. At a speed from 15 to 20 miles per hour the snow would be thrown from 20 to 30 ft. from the track and over fences and stone-walls. In fighting snow it has worked continuously for 24 hours at a stretch, yet never was stalled, derailed, or disabled.

Two men are all that is needed to operate the plow, though eight have ridden in it without discomfort. The body is sheathed inside and out, and the windows have double lights, preventing frost from forming on them, and making the plow warm and comfortable.

This plow is manufactured by the Wilder Snow-plow Co., W. E. Wilder, Manager, Worcester, Mass.

Fig. 2. Position of Nose of Present Type of Snow-Plow on Curve of 45-ft. Radius.

Fig. 3. Position of Nose of Wilder Radial Snow-Plow on Curve of 45-ft. Radius.

A COMBINED SEWER CLEANER AND BUCKET.

The ordinary mechanical sewer cleaner brings dirt to the manhole, there to be shoveled into a bucket for hauling to the surface. Herewith there is illustrated what may be termed a combined cleaner and bucket. Once the line is through the sewer from manhole to manhole and the cable connected to the windlass, the device is operated from the surface of the street, by three men only.

The general design and shape of the cleaner is shown by Fig. 1. The cleaner proper is made of cold rolled steel, and has a sharp-pointed shovel-shaped end, fitted with a flap-valve. This flap-valve, in connection with a removable cover, converts the cleaner into a bucket for lifting its load of dirt to the street level. After being so lifted, the cover is released for emptying by sliding the two bolts shown at the right (Fig 1), slightly lifting the cover to clear that side of the cleaner, then sliding the cover to the right, thus clearing the strap fastenings at the left. The contents of the cleaner are then dumped by tipping the latter. Lugs on the bottom of the cleaner keep it in an upright position, and also pass its cutting edge over slight obstructions at the joints.

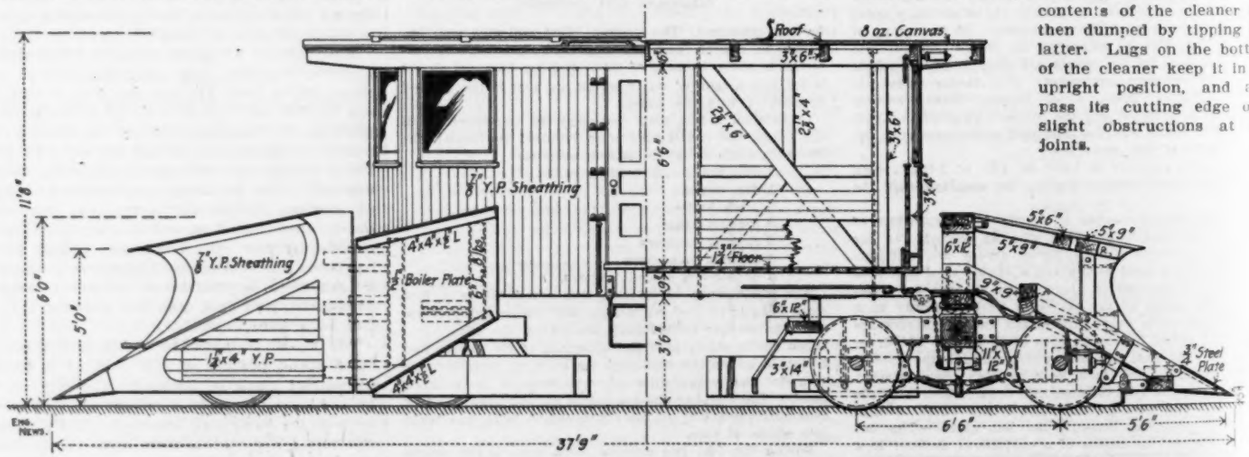


FIG. 4. DESIGN OF WILDER RADIAL SNOW-PLOW.

These cleaners are made in four sizes, for 8 and 10-in., for 12 and 15-in., for 15, 18 and 24-in. sewers, and for sewers more than 2 ft. in size. The largest size cleaner weighs about 80 lbs., and will remove about a wheelbarrow load at one operation, as compared with some two or three ordinary sewer bucketfuls for the smallest size.

Fig. 2 shows roughly the way the machine is connected to the windlass so it may be lifted to the surface without having a man below. In

Fig. 1. Sewer Cleaner Ready to Lower in a 4-ft. Sewer at Harrison, N. J.

lifting, the back cable is slacked after the cleaner reaches the manhole bottom.

The windlass, shown in Fig. 1, has both high and low gear. It weighs about 200 lbs., including 200 ft. of ⅜-in. Swedish iron cable. It can be operated by two men.

The cleaner has been used at Harrison, Weehawken and Roselle Park, N. J., and is now being used in Jersey City. At Harrison the device was used on 3,000 ft. of new sewer, which, it appears, was packed so full of sand that a pipe-forcing jack was required to get a line through it. The contractors for this work were William Green & Sons, Kearney, N. J.

At Weehawken, 2¾ miles of sewer were cleaned. For five days, at this place, twelve truck loads a day were removed from a 3½-ft. sewer, 7 ft. deep. Washings from macadam roads here weighed 80 lbs. a bucketful.

At Roselle Park, nine miles of 8 to 15-in. sewer were cleaned after they had been in operation a year or so, and had been partly filled with so-called quicksand. On Aug. 4, 1904, 570 ft. of 15-in. pipe, at a depth of 23 ft., were cleaned by three men in one day, the deposit of sand and sludge being 6 to 12 ins. deep. John Wallace Higginson, Flatiron Building, New York City, was the engineer for this sewer work.

The machine is now being operated in a 4-ft. sewer in Johnson Ave., Jersey City, which is badly clogged with hard material said to be from a smelting works. The hardness of this material, combined with water in the manholes, is said to have caused the failure of other cleaning devices. The task was all the more difficult, because, according to reports, there was only 6 ins. of clearance in the sewer, making it no easy task to get a line through.

On May 16, 1905, a patent (No. 789,940) on this cleaner was granted to Robert Shannon, of the J. H. & R. Shannon Co., Contractors, 600 Communipaw Ave., Jersey City, N. J.

THE LARGEST DRY DOCK ON THE GREAT LAKES has just been put under contract for the American Ship Building Co. at its yard at Lorain, O. The dimensions of the new dry dock are as follows: Length of basin over all, 720 ft.; length on keel blocks, 700 ft.; width on bottom, 85 ft.; width on top, 125 ft.; depth of water on the entrance sills, 15 ft. 6 ins. The basin will be built of timber supported on piling, and the entrance abutments and aprons will be of concrete. The new dry dock will be provided with every facility for handling work rapidly and will have centrifugal pumps operated by electric motors for emptying the dock. When all the improvements contemplated by the company are completed, the Lorain yard will have a capacity of constructing four ships at one time 700 ft. long, the present capacity being two ships 570 ft. long. The first dry dock at Lorain was built in 1897 and was 500 ft. long on the keel blocks. Three years ago this dock was lengthened to 550 ft., and as soon as the new dock is completed it is intended to again lengthen the old dock. The length of ships on the lakes has increased from 450 ft. in 1897 to 569 ft. in 1904, and a contract has just been made for two ships of 600 ft. in length for 1906 delivery. Plans and specifications for the new dry dock and improvements have been made by Ritchie & Ruple, Civil Engineers, of Cleveland, who also made the plans for the first dry dock and shipyard. The contract for the dry dock has been awarded to The Barnet & Record Co., of Minneapolis. Work on the dredging of the new dock commenced last week.

ANOTHER HUDSON RIVER TUNNEL is planned to extend from Jersey City at Erie and Twelfth Sts., to a terminus in Manhattan on Chambers St., between Broadway and the Brooklyn Bridge terminal. The Interstate Tunnel Co. has been incorporated in both New York and New Jersey to carry out the proposed work. The interest behind the scheme is the Public Service Corporation of New Jersey, which now operates some 550 miles of electric line in the New Jersey suburbs to New York City. This company proposes to supplement its existing facilities in New Jersey by a new direct, high speed line from Newark, with communication, without changes, to the proposed tunnel in Jersey City, thus affording direct transportation from its terminus in Newark to the City Hall in New York in fifteen minutes. Arrangements have also been made for a joint passenger station at Jersey City which will enable the Erie Railroad Company to transfer its suburban passengers to the proposed tunnel line.

THE PANAMA CANAL COMMISSION and the Board of Consulting Engineers sailed from New York for the Isthmus on Sept. 28 by the "Havana" of the Panama R. R. Steamship Line. The vessel will lie at the wharf at Colon during the stay of the Board and will serve as headquarters for the party. A special train on the Panama R. R. will carry them to various points on the Isthmus.

APPLICANTS FOR PANAMA CANAL POSITIONS are soon to be examined by local representatives of the Canal Commission at New York, Chicago and Atlanta. The Commission has decided to appoint three representatives throughout the country to assist the Civil Service Commission in examining applicants for Canal positions. They will rank as members of the Civil Service Commission, and their duty will be the personal examination of applicants for positions involving outdoor labor, such as surveyors, rodmen, carpenters, etc. The present method of written examination has been found unsatisfactory in such cases. The announcement of the appointments is expected in a week or two.

BIDS FOR WATER SUPPLY AND SEWERAGE SYSTEMS for Manila, P. I., will be opened by the municipal board on Jan. 2, 1906. The works for water supply will include a masonry dam, a 42-in. steel pipe line about 10½ miles long, a masonry conduit in tunnel and open cut about 4½ miles long, a receiving and a distributing reservoir, and gates, gate houses and accessories. In the sewerage system there will be 51½ miles of sewers,

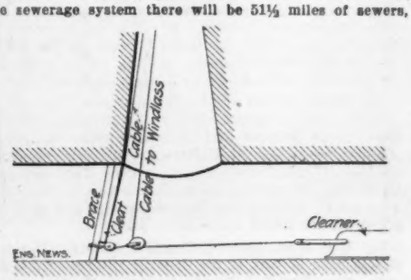


Fig. 2. Sketch of Cable and Pulley Connections for Operating Sewer Cleaner.

of which 7½ miles will be of brick and concrete, in sizes ranging from 4¾ ft. circular to 2 × 3 ft. egg-shaped, laid at depths of 12 to 20 ft., and 43 miles will be 8 to 24-in. pipe sewer, laid 5 to 18 ft. deep. There will also be a 42-in. cast-iron outlet sewer, 6,500 ft. long, laid below the harbor bed on a pile foundation, and a double line of 24-in. flexible joint cast-iron pipe, beneath the Pasig River. Mr. G. S. Lane is Acting Secretary of the Municipal Board, and Mr. J. F. Case is Chief Engineer of the Department of Sewer and Water-Works Construction.

SURVEYS FOR RIVER IMPROVEMENT on the Atlantic Coast of Central America are to be made by Capt. J. F. Le Baron, M. Am. Soc. C. E., who sailed with a party from Mobile, Ala., on Sept. 20. Capt. Le Baron goes out as the Consulting Engineer of the United States & Nicaragua Co., and will make a survey of the bar and the river Prinzapolka, for its entire length, and will devise plans for increasing the depth of water on the bar by jetties and improving the navigation of the entire river. He will also make surveys, plans and estimates for the construction of a dam across the upper part of this river and a hydraulic electric power station capable of furnishing 2,000 HP. for running the mining and milling machinery and mine Electric Ry. of the La Luz y Los Angeles gold mines. He will also make an examination and report on a project for deepening the water at the mouth of the Rio Dulce, Guatemala, by means of jetties, for Guatemala parties. Large coal deposits have been discovered on this river, which is very deep except on the sea bar, and it is with a view of working these deposits that the improvement of the river entrance is desired.

A MEMORIAL ENTRANCE TO CENTRAL PARK, New York City, is proposed by the Andrew H. Green Memorial Association. Some of the reasons for erecting such a memorial are stated in the following extracts from a circular issued by the association:

The debt which New York City owes to Mr. Green's memory is immeasurable. As Member and President of the Board of Education and as Trustee of New York University, the New York Public Library and two great city museums, he contributed greatly to the promotion of public education and the advancement of the arts and sciences. As an officer of philanthropic institutions he gave freely of his time and talents to the amelioration of the condition of the unfortunate. As Commissioner, President and Comptroller of Central Park during its formative years, he was the master-builder of that great institution, which is a daily blessing to the adults and children of the City. As Comptroller of the city's finances at a period when there was vital need of the firmest official integrity, he rescued the municipal credit from disaster and saved millions of dollars to the City Treasury. As member of the Brooklyn Bridge and other Commissions, he promoted many great public improvements upon which the prosperity and daily comfort of millions of people depend. As projector and chief instrument in securing municipal consolidation, with its resultant benefits to all the Boroughs, he was by common consent called the Father of Greater New York.

To the state at large he rendered many notable services, conspicuous among which were his twenty years' service as member and President of the Commissioners of the State Reservation at Niagara Falls, and his pioneer efforts which contributed largely to the saving of the Palisades of the Hudson.

The proposed memorial will be located at the Central Park entrance at Seventh Ave. and 110th St. Of its estimated cost of $75,000 there has been appropriated by the City of New York $50,000. The balance will be raised by subscriptions, which may be sent to Isaac N. Seligman, Treasurer, Mills Building, New York City.

TWO REFUSE DESTRUCTORS of the British type are to be built this side of the Atlantic, and in each provision for heat utilization will be made. At Sacramento, Cal., a destructor with a daily capacity of 40 tons of garbage and other refuse is being installed and the steam generated will be used as auxiliary to the adjoining electric lighting station built some time ago. The town of Westmount, Que., one of the wards of Montreal, has accepted plans for a combined refuse disposal and electric station. The Westmount destructor will have a daily capacity of 50 tons of mixed refuse, and will be equipped with a regenerator for the hot air blast and with a 200-HP. water tube boiler. Messrs. Ross and Holgate, Consulting Engineers, of Montreal, are in charge of the construction of this plant. Both the Sacramento and the Westmount destructors will be of the Meldrum type. The Westmount installation will be made under the direction of Col. W. F. Morse, 17 Battery Place, New York City, representing Meldrum Bros., of Manchester, England.

A SUIT ON ACCOUNT OF ALLEGED STOLEN water has been brought in the U. S. Circuit Court for Ohio. The Washington Water Co., with main offices at Covington, Ky., has sued the Washington Manufacturing Co., of Washington C. H., O., for water alleged to have been taken surreptitiously from a private fire service main connected with the water-works of the first-named company. Payment of $2,794 for water used in this way is demanded.

RECENT CONTRACT TESTS OF MECHANICAL FILters at Danville, Va., showed high reductions in total bacterial contents for ten samples collected on different days. The bacteria ranged from 8,250 in the unfiltered and 4 in the filtered water to 550 and 2, respectively, the average being 3,660 in the unfiltered and 2 in the filtered water. Two of the effluent samples showed no bacteria present and three only 1 per cu. cm. The amount of sulphate of alumina used as a coagulant on the days of the tests varied from 1 to 2 grains per gallon and averaged 1½ grains. The contract called for a 98% reduction of the bacteria in the unfiltered water when the original number was more than 3,000 per cu. cm. and for an absolute reduction to 100 or less when the original bacterial contents were less than 3,000 per cu. cm. These guarantees were largely exceeded in each case. The analyses were made in July and August, 1905, by Mr. Ernest C. Levy, M. D., Sanitary Chemist and Bacteriologist, and Director of the Laboratory of the City Water Department, Rich-

mond, Va. Dr. Levy was engaged by the city to conduct the tests, and his report, addressed to Mr. Frank Talbott, Superintendent of Water, Gas and Electric Lights, Danville, Va., has been printed by the Pittsburg Filter Mfg. Co., of Pittsburg, Pa., the builders of the filter plant.

THE FALL OF A FLOOR in the County Building at Chicago, which is now being pulled down, caused the death of one man and the injury of three others on Sept. 21. Three men with wheelbarrows were passing over a panel of flooring when it collapsed, and it is said that the floors were found to be of very poor construction. The building has been standing for over 20 years.

THE APPROXIMATE POPULATION OF NEW JERSEY by the State Census of 1905 is 2,138,000. This is a gain of 256,000, or 14%, over the U. S. Census of 1900. The only counties showing a decrease were Hunterdon and Sussex, in the northwest and extreme northern part of the State, respectively. Both are rural counties.

PERSONALS.

Mr. Roland Allwork has been appointed an inspecting engineer by the Isthmian Canal Commission.

Mr. John C. Hawley, Jr., of Malden, Mass., has been appointed a civil engineer at Fort McIntosh, Laredo, Tex.

Mr. N. Sinelnikoff, a representative of the Agricultural Department of the Russian Government, is now in this country studying irrigation methods and construction.

Mr. Clarence M. Du Bois, of New Brunswick, N. J., has been appointed an assistant engineer by the Isthmian Canal Commission, with duty on the Isthmus.

Mr. A. A. Holmes, M. Am. Soc. M. E., has been appointed Mechanical Engineer and Electrical Engineer for the Montello Brick Works and the U. S. Brick Co.

Mr. Anthony E. Steere, of Rhode Island, has resigned his position as Engineering Aid in the U. S. Reclamation Service.

Mr. Henry J. Saunders, of Wisconsin, has resigned his position as Assistant Engineer in the U. S. Reclamation Service. He was employed on the Shoshone Project, Wyo.

Mr. Chas. R. Steiner, Assistant Engineer in the U. S. Reclamation Service, has been transferred from the Denver office to duty on Pathfinder dam, Wyo.

Mr. E. W. Vernier, Engineering Aid in the U. S. Reclamation Service, has been transferred from duty under Mr. J. E. Field to Mr. Chas. E. Field, Casper, Wyo.

Mr. R. E. Eberman, formerly draftsman with the Pittsburg Filter Mfg. Co., has been appointed Assistant Engineer with the Greer Filter Co., Philadelphia.

Mr. J. H. Wallace has been appointed Instructor in Mechanical Drawing in the University of Colorado. Mr. Wallace is a graduate of the University of Illinois.

Mr. Edmund J. James, President of the University of Illinois, has been appointed by Governor Deneen as the head of the Illinois State Good Roads Commission.

Mr. David Davies, formerly of the Pittsburg Filter Mfg. Co., has been appointed Superintendent of Erection of the Greer Filter Co., Philadelphia.

Mr. Charles Kirby Fox, formerly of Pomona, Cal., is now located at Culiacan, Sinaloa, Mexico, as a civil engineer for the Sinaloa Land Co.

First Lieutenants Edward M. Adams, Henry C. Jewett and William L. Guthrie, Corps of Engineers, U. S. Army, have been ordered from San Francisco, Cal., to Fort Leavenworth, Kan.

Mr. Alan M. Jones has been appointed Assistant Engineer in charge of construction of the first section on the Grand Trunk Pacific Ry., west of Winnipeg, Man. His headquarters are at Portage La Prairie, Man.

Mr. Fred P. Henshaw, of Massachusetts, has received an appointment as Hydrographic Aid in the U. S. Reclamation Service and has been assigned to the Washington office.

Mr. Eugen F. Kriegman, of Massachusetts, has been appointed Hydrographic Aid in the U. S. Reclamation Service and has been assigned to duty in the Washington office.

Mr. George L. Warner, of Ohio, Assistant Engineer in the U. S. Reclamation Service, has been transferred from Oklahoma work and assigned to duty at Carlsbad, New Mex.

Mr. M. S. Ketchum, Assoc. M. Am. Soc. C. E., Professor of Civil Engineering in the University of Colorado, has been appointed Dean of the School of Applied Science in that institution.

Mr. Howard C. Ford has been appointed Instructor in Civil Engineering in the University of Colorado. Mr. Ford is a graduate of the Civil Engineering Department of that university.

Mr. E. C. Evans, Adjunct Professor of Electrical Engineering in the University of Nebraska, has been appointed Professor of Electrical Engineering in the University of Colorado.

Mr. W. L. Seddon has been appointed Chief Engineer of the Seaboard Air Line Ry., to succeed Mr. W. W. Gwathmey, whose resignation of that position was mentioned in our last week's issue.

Mr. D. R. Jenkins has been appointed Instructor in Electrical Engineering in the University of Colorado. Mr. Jenkins is a graduate of the Electrical Engineering Department of the University of Colorado.

Mr. Frank H. Alfred, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Pere Marquette R. R., to accept a position as General Manager of the Canadian White Co., Ltd., with headquarters at Montreal, Que.

Mr. T. W. Leonard, Manager of Construction of the Canadian Pacific Ry., has been appointed General Superintendent of Transportation of the eastern lines, with offices at Montreal. He succeeds Mr. C. W. Spencer, who has resigned.

Mr. P. H. Porcheron has resigned his position as City Engineer of Rome, N. Y., and has accepted a position as Superintendent of Construction at West Point, N. Y. Mr. John L. Plunkett, heretofore Assistant Engineer, has been appointed City Engineer of Rome for the balance of the year.

Mr. G. Edward Smith and Mr. William W. Robinson, both of whom were formerly with the Cramp Co., have entered into a partnership under the firm name of Smith & Robinson, and have opened an office at 605 Provident Building, Philadelphia, Pa., where they will engage in engineering work.

Mr. A. E. Winter, Assistant Engineer of the Chicago & Northwestern Ry., has been appointed Foreman of Bridges and Buildings on the Wisconsin Division, with headquarters at Fond du Lac. He succeeds Mr. C. A. Lichty, who has been appointed to the purchasing department, with offices at Chicago.

Mr. Chas. E. Miller, M. Ohio Soc. of M. E. and S. E., who has for several years held the various positions of draftsman, designer and engineer with The Diamond Rubber Co., Akron, O., has recently become connected with the Alton Machine Co., of New York City, having shops in Harrison, N. J. Mr. Miller assumes the duties of Superintendent of the rubber and wire machinery departments.

Mr. A. J. Major, President of the American Bridge Co. since 1901, has resigned that position, and is succeeded by Mr. August Ziesing, M. Am. Soc. C. E. It is understood that Mr. Major has not made any other business connections, and will enjoy a respite from business cares for the present. Mr. Ziesing, the newly elected president, has for some years been Western Manager of the company, with offices at Chicago.

Mr. C. C. Mallard, formerly in the Maintenance of Way Department of the Houston & Texas Central R. R., with headquarters at Houston, Tex., and previous to that Assistant Superintendent of the Louisiana Lines of the Southern Pacific Co., at Lafayette, La., has accepted a position as Assistant Engineer of the Gila Valley, Globe & Northern Ry., Globe, Ariz., and will have charge of the reconstruction of a part of its line.

Dr. A. B. Houston, of London, England, has been appointed Director of Water Examinations to the Metropolitan Water Board. The Board controls the works recently bought from the various water companies that formerly supplied London. Dr. Houston is known by many in America for his bacterial work on the London sewage treatment experiments and for similar work done for the Royal Commission on Sewage Disposal.

Mr. Donald Derickson, for the past two years an Instructor in Civil Engineering at the Pennsylvania State College, has resigned that position in order to accept a similar one at Cornell University. Mr. Derickson is a graduate of the Thayer School of Civil Engineering, of Dartmouth College, and has had several years' experience with the U. S. Coast and Geodetic Survey, and as an engineer for the Berlin Construction Co.

Mr. A. S. Zinn, formerly Principal Assistant Engineer, Maintenance of Way of the Choctaw District of the Chicago, Rock Island & Pacific Ry., with headquarters at Oklahoma City, Okla., has accepted a position as Assistant to Mr. E. H. Lee, Chief Engineer of the Chicago & Western Indiana R. R., of Chicago, and will devote his time to track elevation work. The offices of Principal Assistant Engineers, Maintenance of Way and Division Engineers on the Chicago, Rock Island & Pacific Ry. have been abolished, and the Maintenance of Way work is now handled by the Division Superintendents.

Obituary.

Frederick T. Camp, a well-known architect, died Sept. 19 at his home in Bloomfield, N. J. He was 56 years old.

Frank B. Hoskins, President of the Eastern Wisconsin Railway & Light Co., of Fond du Lac, Wis., died Sept. 19 in that city.

Frank A. Barstow, of Haverford, Pa., General Agent at Philadelphia of the Safety Car Heating & Lighting Co., was killed Sept. 25 in a railway collision at Paoli, Pa.

W. P. Appleyard, President of the Master Car Builders' Association, and Superintendent of Equipment of the Pullman Co., was struck by a train and killed at 63d St. station of the Illinois Central R. R., Chicago, Sept. 19. He was connected with the mechanical department of the Pullman Co. as early as 1888, but was Master Car Builder of the New York, New Haven & Hartford R. R. from 1895 to 1905, when he returned to the Pullman Co. While connected with the New Haven company Mr. Appleyard invented a systeem of copper sheathing for finishing the exterior of passenger cars instead of paint and varnish which attracted much attention from railway officials and has been put into use to some extent.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN PUBLIC HEALTH ASSOCIATION
Sept. 25 to 29. Annual meeting at Boston, Mass. Secy., Dr. Chas. O. Probst, Columbus, O.

AMERICAN STREET RAILWAY ASSOCIATION.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION.
Sept. 25-30. Annual convention at Philadelphia, Pa. Secy., T. C. Penington, 2020 State St., Chicago, Ill.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

LAKE SUPERIOR MINING INSTITUTE.
Oct. 17, 18. Annual meeting on the Menominee Range, with excursion. Secy., A. J. Yungbluth, Ishpeming, Mich.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

APPALACHIAN ENGINEERING ASSOCIATION.—This young society held a meeting at Huntington, W. Va., on Sept. 16, with about 30 members in attendance. Addresses were made by Gen. E. Gaujot and Mr. J. A. Dillard. A paper on "Economy of Steel Construction in Office and Shop" was read by Prof. W. H. Boughton, of Morgantown, W. Va. The next meeting of the association is to be held at the Bluefield Inn, Bluefield, W. Va., on Saturday, Nov. 4, at 8.30 p. m. Secy., H. M. Payne, Williamson, W. Va.

MILWAUKEE SOCIETY OF MECHANICAL ENGINEERS.—This society has been recently organized and a large membership is expected from among the engineers, superintendents, electricians, etc., of the numerous large engineering, industrial and manufacturing establishments in and around Milwaukee. It has at present some 50 members, and monthly meetings are to be held during the winter. President, George P. Drave, Consulting Engineer; Vice-President, C. J. Davidson, Chief Engineer of the Milwaukee Street Ry. Co.; Treasurer, E. P. Worden, Mechanical Engineer of the Prescott Pump Co.; Secretary, W. G. Starkweather, of the Allis-Chalmers Co.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the second meeting of the season, held at the society's house, 220 West 57th St., New York City, on the evening of Sept. 20, Mr. D. A. Watt presented a paper entitled "Notes on the Improvement of River and Harbor Outlets in the United States." The paper advanced some new views as to the laws governing water action at river outlets, and therefore also governing the nature and form of channel improvements at such outlet. These views were subjected to extensive criticism in written communications from Mr. L. J. Le Comte and Capt. W. W. Harts, the latter in particular traversing Mr. Watt's conclusions in nearly every point.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The first meeting of the season was held on the evening of Friday, Sept. 22, in the Edison Auditorium, 44 West 27th St., New York City. The new President, Mr. S. S. Wheeler, occupied the chair for the first time. Two papers were presented: "Air-gap Flux in Induction Motors," by Mr. A. S. Langsdorf, and "Standardization of Enclosed Fuses," by Mr. H. O. Lacount. The latter paper recited the principal considerations which affect the work of standardizing the sizes, terminal fittings, blowing points, temperature rise, and testing of enclosed fuses, and then described the work and results of the National Electric Code Committee on this subject. Working standards were adopted by this committee during the past year, and have been published by them. The work is not fully closed, however, as only the test of use can tell whether these standard specifications meet all requirements or not. The paper led to some interesting discussion, rather shortened by the brief time available for it. Mr. L. W. Downes, Prof. F. B. Crocker, Mr. H. G. Stott and Mr. Jos. Sacks, among others, spoke in discussion. Some doubt was expressed by both Mr. Downes and Mr. Sacks whether the clip form of terminal recommended by the Committee would prevail as the general standard, in the face of the wide demand for a screwed clamp terminal. The discussion relating to capacity of system on which fuses should be tested, and to tests of fuses for use on elevated railways, led to the conclusion that the standardizing of fuses cannot be expected to cover such extreme service as, for example, on the collecting shoe of a third-rail line, where the great inductive effect of the steel conductor-rail acts to produce abnormal potential rise across the fuse at the moment of blowing.